WORLD DEMAND PROSPECTS FOR GRAIN IN 1980

WITH EMPHASIS ON TRADE BY THE LESS DEVELOPED COUNTRIES

FOREIGN AGRICULTURAL ECONOMIC REPORT NO. 75
U.S. DEPARTMENT OF AGRICULTURE • ECONOMIC RESEARCH SERVICE

ABSTRACT

World supply, demand, and trade of wheat, rice, and coarse grains are projected to 1980 under three basic alternative sets regarding economic development, production growth rates, and policies of major developed trading countries. Focus is centered on world demand prospects for exports of the less developed countries (LDC's). Grain export prospects are fair for wheat, poor for rice, and good for coarse grains. Supplies of grains appear likely to exceed demand at base period (1964-66) prices. Import demand of the LDC's for wheat and coarse grains may increase rapidly if concessional terms of trade are available. LDC's may find it difficult to achieve a consensus on trade policy, since they include both importers and exporters.

Key words: World supply, demand, trade, 1980 projections, wheat, rice, coarse grains, grains, less developed countries.

Washington, D.C. 20250 December 1971

FOREWORD

Grain is basic to the agricultural economy of nearly every country in the world. This commodity group—wheat, rice, and coarse grains—accounts for a large part of total food consumption, either directly as grain and grain products or indirectly as grain-fed livestock and their products. Internationally, grain is one of the most widely traded commodity groups, accounting for about one-fifth of world agricultural trade. Significant changes have occurred in the basic supply-demand relationships of this commodity group. On the supply side, the successful introduction of high-yielding grain varieties in some less developed countries (LDC's) has been heralded as a "Green Revolution." On the demand side, there has been a substantial boost in the use of grains for feed in developed areas.

This study focuses on the long-term demand for grain, especially from the perspective of potential exports of LDC's. In doing so, demand and trade projections for 1980 are made under three basic sets of assumptions using 1964-66 as a base period. From these, the following trade implications are advanced.

Demand prospects for wheat are only fair, with import demand forecast to be sluggish in developed areas but potentially strong in LDC's if concessional terms of trade are available. The outlook for rice is poor. Continuation of the Green Revolution would result in lower world import demand, which is traditionally centered in the LDC's. For coarse grains, the demand prospects are good and import demand in developed regions, particularly Japan, is expected to be strong.

This study is part of the research project on "Demand Prospects for Agricultural Products of Less Developed Countries" conducted by the Economic Research Service under a participating agency service agreement for the Agency for International Development. The research was conducted under the direction of an ERS Technical Advisory Committee, with Louis F. Herrmann as Chairman. Arthur B. Mackie and Anthony S. Rojko served as advisers and research leaders.

Douglas Caton
Senior Agricultural Adviser
Bureau of Technical Assistance
Agency for International Development

PREFACE

Several aspects of this project are being or have been published in a series of studies that are listed on the inside back cover of this report. The studies pertaining to grain were prepared by the following Economic Research Service staff members: James J. Naive*, John E. Hutchison, and Sheldon K. Tsu for wheat; James F. Keefer*, Robert D. Barry, and Amjad H. Gill for rice; Donald W. Regier* and O. Halbert Goolsby for feed grain; Anthony S. Rojko*, Francis S. Urban, and James J. Naive for total grains; Joseph R. Barse* for trade policies and Japanese food strategies; A. Nicholas Filippello* for the Japanese grain-livestock economy; and Lyle E. Moe and Malek M. Mohtadi for population and income.

Many individuals gave valuable assistance throughout this project. A. Nicholas Filippello was especially helpful in the formulation and computerization of the world grain model. Appreciation is extended to Quentin M. West, Joseph W. Willett, and Harry E. Walters for their constructive ideas; and to Charles A. Gibbons for his counsel on data problems.

In addition, the authors are indebted to Louis F. Herrmann, chairman of the project's technical advisory committee, Martin E. Abel, chairman at the start of the project, and the members of the research team for their individual and joint contributions. The authors are, however, fully responsible for the choice of data and information used and for the interpretations and conclusions drawn.

*Project leaders.

CONTENTS

	Page
SUMMARY	vii
I.—INTRODUCTION	1
Purpose of Study	1
Terms and Definitions	1
II.—MAJOR GRAIN MARKETS AND SUPPLIERS	2
Wheat	2
Rice	6
Coarse Grains	9
III.—TRADE POLICIES	13
Agricultural Import Barriers	13
General Trade Policies: Japan	15
IV.—A WORLD TRADE MODEL	24
Variables in the Model	24
Model I - Basic Simultaneous Equations Solution	25
Model II - The Economic Framework for Linear Programming	26
Some Specific Observations	26
Adaptations to a "Real" World	27
V.—DEMAND ANALYSIS	27
Relative Importance of Grain Uses	28
Economic Development and Demand for Grain	28
Price Response and Substitution Effects	30
Demand Elasticities and Trends for Projections Model	34
Prices and World Market Supplies	38
Demand for Stocks	40
VI.—SUPPLY RESPONSE	41
Price Effect on Production and Market Supply	41
Effect of Technological Change on Production	46
VII.—FRAMEWORK FOR PROJECTIONS TO 1980	50
General Assumptions	51
Basic Equations	52
Transportation Matrix	57
Specific Assumptions	60
VIII.—PROJECTIONS OF DEMAND, SUPPLY, AND TRADE	63
Projection Set I	63
Projection Set II	70
Projection Set II-A	71

Page

Projection Set II-B 75
Projection Set III 75
Other Projection Sets 76

IX.—IMPLICATIONS FOR TRADE OF LESS DEVELOPED COUNTRIES 87
Projection Set I 89
Projection Set II 91
Projection Set II-A 92
Projection Set II-B 92
Projection Set III 92
Commodity Prospects 93

REFERENCES 95

APPENDIX A 103

APPENDIX B 132

APPENDIX C 135

TABLES

Number		*Page*
1	World wheat imports and exports, by region, averages 1955-66	3
2	Regional share of world wheat imports and exports, averages 1955-66	4
3	World rice imports and exports, by region, averages 1954-56, 1959-61, and 1964-66, annual 1967	7
4	Regional share of world rice imports and exports, averages 1954-56, 1959-61, and 1964-66, annual 1967	8
5	World coarse grains imports and exports, by region, averages 1951-53 and 1963-65	11
6	Regional share of world coarse grains imports and exports, averages 1951-53 and 1963-65	12
7	Trade barriers to grain imports in developed countries	16
8	Import quotas: Total and per capita for wheat, rice, corn, and barley in developed countries, 1968 or 1969	22
9	Tariff rates: Approximate ad valorem equivalents for specific duties on grain imports, 1968 or 1969	23
10	Critical ranges in the development sequence of a world grain - livestock economy	31
11	World grain model: Demand elasticities and net trend assumed in projections to 1980	35
12	World grain model: Supply elasticities and net trend assumed in projections to 1980	43
13	Results of fertilizer trials and demonstrations on corn, wheat and rice, selected countries	48
14	Total world population, 1965, and projections to 1980	53
15	National incomes, 1965, and projections to 1980 under projection sets I, II, and III	54
16	World grain model: Sensitivity coefficients assumed in projections to 1980	59
17	Wheat: Production, consumption, and trade, 1964-66 average, and projections to 1980 under projection sets I and II	65
18	Rice: Production, consumption, and trade, 1964-66 average, and projections to 1980 under projection sets I and II	67
19	Coarse grains: Production, consumption, and trade, 1964-66 average, and projections to 1980 under projection sets I and II	69
20	Wheat: Production, consumption, and trade, projections to 1980 under projection sets II-A, II-B, and III	72
21	Rice: Production, consumption, and trade, projections to 1980 under projection sets II-A, II-B, and III	73
22	Coarse grains: Production, consumption, and trade, projections to 1980 under projection sets II-A, II-B, and III	74
23	Total grains: Production, consumption, and trade, 1964-66 average, and projections to 1980 under projection sets I and II	78
24	Total grains: Production, consumption, and trade, projections to 1980 under projection sets II-A, II-B, and III	79
25	Wheat: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets I and II	80
26	Rice: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets I and II	81

Number		*Page*
27	Coarse grains: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets I and II	82
28	Wheat: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets II-A, II-B, and III	83
29	Rice: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets II-A, II-B, and III	84
30	Coarse grains: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets II-A, and II-B, and III	85
31	Wheat: Export earnings and import costs, 1964-66 average, and alternative projections to 1980	86
32	Rice: Export earnings and import costs, 1964-66 average, and alternative projections to 1980	88
33	Coarse grains: Export earnings and import costs, 1964-66 average, and alternative projections to 1980	90
34	Total grains: Export earnings and imports costs, 1964-66 average, and alternative projections to 1980	94

APPENDIX TABLES

Number		*Page*
A-1	Ocean freight rates for heavy grains in voyage chartered foreign flag vessels	128
A-2	Wheat: Export and import prices, 1964-66 average, and projections to 1980 under alternative projection sets	129
A-3	Rice: Export and import prices, 1964-66 average, and projections to 1980 under alternative projection sets	130
A-4	Coarse grains: Export and import prices, 1964-66 average, and projections to 1980 under alternative projection sets	131
C-1	World trade in wheat and wheat flour, 1963-65 average	139
C-2	World trade in wheat, 1980, projection set I	140
C-3	World trade in wheat, 1980, projection set II	141
C-4	World trade in rice, 1963-65 average	142
C-5	World trade in rice, 1980, projection set I	143
C-6	World trade in rice, 1980, projection set II	144
C-7	World trade in coarse grains, 1963-65 average	145
C-8	World trade in coarse grains, 1980, projection set I	146
C-9	World trade in coarse grains, 1980, projection set II	147

SUMMARY

World grain projections to 1980 based on 1964-66 average prices indicate that growth in unconstrained production would most likely exceed growth in demand. Prices would probably decline, therefore, unless major developed exporters continued to pursue a price stabilization policy by adjusting production and marketing. Willingness of developed importers to adjust production would also mitigate the pressure on prices. Maintenance of reasonable world price levels is essential if the less developed countries (LDC's) are to improve their export earnings from grain during the 1970's. LDC export earning prospects would vary among wheat, rice and coarse grains.

World trade prospects are fair for wheat, with import demand forecast to be sluggish in developed areas but potentially strong in the LDC's if concessional terms of trade are available. Increased feed use of wheat would reduce downward pressures on prices. Some increase in the share of the world market is possible for LDC exporters, largely Argentina. Potential export earnings in South Asia under an accelerated growth in wheat production could be offset by high subsidy costs and the relatively lower demand and prices for the low-quality varieties.

The outlook for rice is poor. Continuation of the "Green Revolution" would result in lower world import demand, a demand traditionally centered in the LDC's. Import demand in the developed area is expected to rise moderately, but the increase will be small relative to potential export supplies—from both developed and less developed exporters. Consequently, continued downward pressures on prices are expected. The impact of reduced import demand in the LDC's resulting from the uptrend in production would probably be concentrated on the traditional rice suppliers (primarily Southeast Asia). Thus, export earning prospects for these countries are poor. If Japan shifted from its current self-sufficiency position to a substantial import position, trade prospects would most likely improve.

Demand prospects for coarse grains are good. Import demand in developed areas, particularly Japan, is expected to be strong. Some LDC exporters might not fully share in the expansion because their port facilities are limited in handling large cargo vessels. Given concessional terms of trade and rapid expansion in the livestock industry, import demand in the LDC's could increase sharply. Lower internal grain prices in importing developed countries, particularly in the European Community (EC), could give trade an additional boost. A further trade boost is possible from Japan if her food strategy is to approach "Western" consumption levels of meat and livestock products. On the other hand, EC maintenance of very high internal prices through limited access of cheaper imports could stimulate production and lead to self-sufficiency in total grains in the EC.

An expanded EC (United Kingdom, Denmark, Ireland, and Norway) with high internal prices could further limit world import demand.

On balance, the projections lead to the following general implications for the LDC's:

Much of the increase in grain production in the LDC's would be absorbed by increased domestic consumption. Thus, per capita nutritional levels of the LDC's may be expected to improve.

Demand in the LDC's for grain may increase rapidly, particularly for wheat in those areas in which it is not produced. But increased LDC grain imports would be contingent on concessional terms of sale to the LDC's.

The relationship between world grain price levels and volume of trade may be indeterminate under certain conditions. Lower world prices may be associated with decreased trade if production increases occur in importing countries (as is expected for rice) and import demand is lowered. On the other hand, lower world prices may be associated with increased trade if production increases occur in exporting countries and exports are increased (as is likely for wheat).

Because of the inelastic demand response for grain at the world level and because the world market is supplied largely by developed exporters, their policies can drastically affect the export earning prospects of the LDC's. A possible strategy for LDC's would be to increase exports to the point that major developed exporters might find it expedient to accommodate, possibly through some cooperative international effort. Expanding exports beyond that point may cause the developed exporters to adopt market-sharing policies that would reduce world price levels and thereby adversely affect LDC export earnings.

Benefits to LDC's from removal of import restrictions and freer trade may be minimal if developed exporters share in the increased market, unless special trade arrangements are made in favor of the LDC's. Specifically, since the developed exporters have the

largest share of the import market in wheat and coarse grains, they would gain relatively more from an expanded import market than the LDC exporters if current market shares are maintained.

Accelerated production in LDC's could lead to lower export earnings which could discourage economic growth. This would conflict with the assumption made in one of this study's alternative projections where both production and economic growth in the LDC's were assumed to increase.

LDC's may find it difficult to achieve a consensus on trade policy, since the less developed area includes both importers and exporters. Lower world prices benefiting importers would adversely affect exporters, and higher world prices benefiting exporters would adversely affect importers.

These conclusions are based on three basic projection sets, each within a supply-demand framework. Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the LDC's. Under sets II and III, respectively, higher and lower rates of agricultural productivity and economic growth in the LDC's would prevail than under set I. Major emphasis is placed on sets I and II, since they are more consistent with current national development plans of the LDC's to accelerate economic growth by increasing agricultural production. Set III illustrates the effect on export earnings of shortfalls in development objectives of the LDC's. Set II includes subsets to evaluate the effect of varying policies in major developed trading countries. Under set II, major developed exporters follow policies to maintain reasonable world price levels in the face of large increases in LDC grain production, but under set II-A their policy shifts to maintenance of market shares even though this results in low prices. Set II-B tests the impact of freer entry into developed importing countries.

WORLD DEMAND PROSPECTS FOR GRAIN IN 1980

WITH EMPHASIS ON TRADE BY THE LESS DEVELOPED COUNTRIES

Anthony S. Rojko, Francis S. Urban, and James J. Naive[1]

I.—INTRODUCTION

In recent years, the role of foreign trade in economic development has been focused on by researchers and administrators alike. Its importance as a determinant for economic growth is now being questioned, primarily because demand for the traditional exports of less developed countries (LDC's) has not increased as rapidly as their exportable supplies. Consequently, prices of their goods have tended to decline. And since the prices of products imported by LDC's have tended to rise, the purchasing power of their exports has fallen.

Instability of export earnings of the less developed countries adds to their problems created by price uncertainty and often distorts optimum resource allocation and use. It can also contribute to balance-of-payment problems when imports are not held in check. And, if restrictions are imposed to check imports, the rate of economic growth can be thwarted.

Agricultural exports have often been considered a linchpin for generating the foreign exchange needed for the national economic development plans of the LDC's. However, these exports are now showing signs of being an insufficient generating force or, at least, a disappointing link between economic development planning and economic growth.

Purpose of Study

The major objective of this study is to estimate 1980 world demand prospects for grains—wheat, rice, and coarse grains—and to outline the implications of possible production and trade policies and programs on the world grain economy. Grains are an important aspect of the trade balance of the LDC's from the standpoint of either export earnings or import costs. A firm understanding of the entire demand structure for grains is necessary to properly evaluate the role of grain in the agricultural development policies of the LDC's.

Analyses of factors affecting regional supply and demand for wheat, rice, and coarse grains are facilitated in this report by the use of an econometric model. These analyses take into account the interactions of economic forces within the world grain economy. The overall research project—of which this study is a part—includes separate studies on wheat, rice, and coarse grains (see Preface). In contrast with the present study, these separate studies focus more narrowly on the respective grain sector.

Results of analyses in this study should provide an overview of the magnitude of current and future world grain trade; identify the pattern of international trade flows; and outline the importance of different supply, demand, and policy conditions with respect to export earning prospects of the LDC's.

Terms and Definitions

Units of Measurements

Metric units are used unless noted otherwise.

Trade

In most cases, wheat flour is included in wheat equivalents. The July 1/June 30 trade year was generally used in calculating consumption of wheat and coarse grains. Calendar year trade was used for rice.

Stocks

Data on grain stocks were adjusted to a July 1 basis when possible for wheat and coarse grains and to a January 1 basis for rice. However, data for many countries were not available.

Consumption

In this study, consumption includes grain used for food, feed, seed, waste, and industrial purposes. It equals production plus imports, less exports, and change in the stocks.

[1] The authors are agricultural economists in the Foreign Regional Analysis Division, Economic Research Service.

Regional Groupings

The world was divided on the basis of economic, geographic, and political criteria into 22 regions and three major areas—developed, central plan, and less developed. Groupings are listed in appendix A.

In the presentation of projections, the regions in the developed and less developed areas are further classified as major importer or exporter. This classification may vary for wheat, rice, and coarse grains.

II.—MAJOR GRAIN MARKETS AND SUPPLIERS

The pattern of world grain trade changed decidedly during the 1960's. The decade was one of nontraditional trade, with instances of exporting countries becoming importers and importing countries becoming exporters. The trend of world grain trade was upward, though not continuously; exports reached a peak in the mid-1960's but dropped substantially thereafter.

These shifts and fluctuations can be attributed to changes in economic growth, production and trade policies, and consumers' tastes and preferences, as well as to factors such as technology, meteorological conditions, and military conflicts. This chapter highlights the patterns and trends of trade and the significant shifts that have occurred. More detailed discussions are included in individual reports on the three commodities covered in this report (*71*, *80*, *116*). [2]

Wheat[3]

Over the long run, the principal wheat exporters have been the United States, Canada, Argentina, and Australia (*77*). By the mid-1960's, countries in the European Community (EC), mainly France, had joined the group of major wheat exporters. The USSR has usually been a wheat exporter, but mainly within the confines of the central plan area and outside the normal activity of the international market.

The class of wheat moving through foreign trade varies among the shippers. The United States has exportable supplies of most classes and subclasses including hard spring and winter, soft winter, white and durum. Canada is largely a hard spring (Manitoba) exporter, though a substantial volume of durum is also shipped. Traditionally, Australia and Argentina have exported medium hard wheats, which have been used for blending. In addition, Argentina has exportable supplies of durum. Nearly all of the wheat exported by the EC is of the soft class.

Major Wheat Markets

The major world markets for wheat have been Japan, the EC, and the European Free Trade Association (EFTA) in the developed area; Eastern Europe and Mainland China in the central plan area; and India, Pakistan, Brazil, and the United Arab Republic (UAR) in the less developed area (*71*).

During 1964-66, world wheat imports averaged 57.4 million tons. Of this, the LDC's accounted for 40 percent; the central plan area, 34 percent; and the developed countries, 26 percent (tables 1 and 2).

Wheat imports by the central plan area during this period were unusually large because of Soviet purchases resulting from poor grain harvests in 1963 and 1965. USSR imports averaged 7.6 million tons in 1964-66, compared with only 1.1 million tons during the preceding 3 years. In 1961-63, the central plan area as a whole accounted for only 10 percent of world imports.

In 1964-66, Japan's average annual wheat imports of 3.7 million tons accounted for 6.5 percent of the world total; the EC's imports of 4.5 million tons accounted for 7.8 percent; and EFTA's 5.7 million tons accounted for 9.9 percent. West Germany and the Netherlands were the largest country markets in the EC, although other member countries imported substantial quantities. In EFTA, the United Kingdom was by far the largest market.

In the less developed area, three regions—South Asia, Latin America, and North Africa—accounted for three-fourths of LDC wheat imports. As shown below, the imports of only four countries—India, Pakistan, Brazil, and the UAR—accounted for 55 percent of LDC imports:

	1,000 tons	Percentage of LDC wheat imports
India	6,648	29.2
Pakistan	1,456	6.3
Brazil	2,311	10.1
UAR	2,081	9.1
	12,496	54.8

However, the import needs of India and Pakistan in 1964-66 were unusually large because of poor harvests during the severe drought years of 1965 and 1966.

[2] Underscored numbers in parentheses refer to references listed at the end of this report.

[3] For the most part, trade data in this section are based on calendar years and include flour in wheat equivalent. The regional classification and much of the data are given in (*71*).

Table 1.--World wheat imports and exports, by region, averages 1955-66

Region	Exports				Imports			
	1955-57	1958-60	1961-63	1964-66	1955-57	1958-60	1961-63	1964-66
	1,000 metric tons							
Developed:								
United States	10,424	12,482	18,067	21,747	235	221	153	45
Canada	7,629	8,096	10,227	14,773	2	2	--	--
Japan	17	25	85	69	2,327	2,520	2,896	3,738
EC	2,629	3,079	3,231	6,053	5,759	4,579	5,515	4,457
EFTA	233	119	442	410	6,652	6,196	5,763	5,678
Other Western Europe	35	250	240	132	996	729	1,251	583
Australia, New Zealand, & South Africa, Rep. of	2,788	2,413	5,640	6,092	383	401	340	425
Subtotal	23,755	26,465	37,932	49,276	16,354	14,648	15,918	14,926
Central plan:								
Eastern Europe	235	256	177	169	4,418	4,160	5,508	6,369
USSR	2,814	3,950	4,273	2,369	179	181	1,075	7,566
Communist Asia	--	53	1	57	30	90	4,569	5,751
Subtotal	3,049	4,259	4,451	2,595	4,627	4,431	11,152	19,686
Less developed:								
Latin America	3,076	2,393	1,852	5,270	3,401	3,803	4,558	6,046
North Africa	361	328	91	103	809	2,028	2,908	3,399
West Africa	--	--	9	16	300	415	570	508
East Africa	--	--	4	4	170	227	264	351
West Asia	233	217	99	54	1,263	1,485	2,215	1,815
South Asia	--	--	--	3	2,026	4,984	4,627	8,466
Southeast Asia	--	--	--	--	121	139	206	221
Other East Asia	--	4	31	51	924	1,124	1,511	1,487
Far East & Oceania	--	102	1	40	475	455	541	508
Subtotal	6,670	3,044	2,087	5,541	9,489	14,660	17,400	22,800
World total	30,474	33,769	44,470	57,412	30,474	33,769	44,470	57,412

Note: Dash indicates no trade or trade of less than 500 metric tons.

Source: (89) updated.

Table 2.--Regional share of world wheat imports and exports, averages 1955-66

Region	Exports				Imports			
	1955-57	1958-60	1961-63	1964-66	1955-57	1958-60	1961-63	1964-66
	Percent							
Developed:								
United States	34.2	37.0	40.6	37.9	0.8	0.7	0.3	--
Canada	25.0	24.0	23.0	25.8	--	--	--	--
Japan	0.1	0.1	0.2	0.1	7.6	7.6	6.5	6.5
EC	8.6	9.1	7.3	10.6	18.9	13.6	12.4	7.8
EFTA	0.8	0.4	1.0	0.7	21.8	18.2	13.0	9.9
Other Western Europe	0.1	0.7	0.5	0.3	3.3	2.2	2.8	1.0
Australia, New Zealand, & South Africa, Rep. of	9.1	7.1	12.7	10.6	1.3	1.2	.8	0.7
Subtotal	77.9	78.3	85.3	86.0	53.7	43.5	35.8	25.9
Central plan:								
Eastern Europe	0.8	0.8	0.4	0.3	14.4	12.3	12.4	11.1
USSR	9.2	11.7	9.6	4.2	0.6	0.5	2.4	13.2
Communist Asia	--	0.2	--	0.1	0.1	0.3	10.3	10.0
Subtotal	10.0	12.7	10.0	4.6	15.1	13.1	25.1	34.3
Less developed:								
Latin America	10.1	7.1	4.2	9.2	11.2	11.3	10.2	10.5
North Africa	1.2	1.0	0.2	0.2	2.7	6.0	6.5	5.9
West Africa	--	--	--	--	1.0	1.2	1.3	0.9
East Africa	--	--	--	--	0.6	.7	0.6	0.6
West Asia	0.8	0.6	0.2	--	4.1	4.4	5.0	3.2
South Asia	--	--	--	--	6.6	14.8	10.4	14.8
Southeast Asia	--	--	--	--	0.4	0.4	0.5	0.4
Other East Asia	--	--	0.1	--	3.0	3.3	3.4	2.6
Far East & Oceania	--	0.3	--	--	1.6	1.3	1.2	0.9
Subtotal	12.1	9.0	4.7	9.4	31.2	43.4	39.1	39.8
World total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Dash indicates no trade or trade of less than 500 metric tons.

Source: Computed from data in table 1.

Major Wheat Suppliers

The United States, Canada, Australia, Argentina, France, and the USSR are the major exporters of wheat. These suppliers accounted for about 95 percent of world wheat trade in 1964-66.

During 1964-66, the developed area purchased five-sixths of its imports from the United States, Canada, Australia, and Argentina. The remaining one-sixth came mostly from European countries (chiefly France).

In the Japanese market, the United States and Canada were the major suppliers, accounting for 52 and 36 percent of the imports, respectively; Australia accounted for nearly all of the remainder. In the EC, the United States, Canada, and Argentina supplied just over three-fourths of the imports; intra-Community trade (mainly from France) accounted for most of the remainder. Over half of EFTA's imports, which are mainly U.K. purchases, were taken from Canada and Australia, which accounted for 43 and 12 percent of the purchases, respectively. U.S. exports accounted for 15 percent of EFTA's imports, and the EC accounted for 22 percent.

As mentioned previously, 1964-66 was an unusual period for the Soviet Union because it had to purchase very large quantities of wheat. Canada was by far its largest supplier, accounting for 57 percent of the imports. Other countries supplying significant amounts were: Australia (12 percent), the EC—mainly France—(11 percent), Argentina (10 percent), and the United States (8 percent).

Eastern Europe's imports in 1964-66 averaged 6.4 million tons. Major suppliers included the USSR (28 percent), the United States (24 percent), the EC (21 percent), and Canada (20 percent). Imports by Communist Asia (principally Mainland China) of 5.8 million tons came mainly from Australia, Canada, and Argentina.

The less developed area's wheat imports are mainly from the developed exporters and Argentina. In 1964-66, the area's imports averaged 22.8 million tons; well over half were imported under special transactions, mainly food assistance programs.[4] Because of its food aid program under Public Law 480, the United States was by far the largest supplier of the LDC's, accounting for two-thirds of their imports.[5]

In South Asia, where imports averaged 8.5 million tons, the United States supplied 86 percent; and Australia and Canada 6 percent each. In Latin America, where imports averaged 6.0 million tons, the United States supplied 47 percent; other major suppliers were Argentina (27 percent) and Canada (16 percent). The Soviet Union was also a supplier to Latin America (largely Cuba), providing 8 percent of the total.

The United States was the major wheat supplier in North Africa during 1964-66, providing 70 percent of the average imports of 3.4 million tons. The EC (mainly France) was the other large supplier to this region.

In West Asia, the United States and Australia were the two major suppliers, accounting for 62 and 24 percent of the average annual imports of 1.8 million tons. In Other East Asia (mainly South Korea, Taiwan, and the Philippines), the United States supplied nearly three-fourths of total imports; Canada and Australia were the other main suppliers.

Changes in Historical Patterns

The level of world wheat trade increased sharply from 1955-57 to 1964-66, rising 7.3 percent annually from an average of 30.5 million to 57.4 million tons (table 1). But 1964-66 was a period of unusually strong import demand and if the average for the previous 3 years (1961-63) were used for comparison, the annual growth rate would be reduced to 6.5 percent.

In addition, it should be noted that world wheat trade has dropped substantially since 1964-66. The Soviet Union has recovered from the poor crops of 1963 and 1965 and is not nearly as active an importer in the international market. India and Pakistan, who harvested three very good food grain crops in 1968-70, have substantially lowered their import needs.

A decided shift has also occurred in the pattern of world wheat trade. During 1955-57 to 1964-66, average annual imports of the developed area dropped in both absolute and relative terms from 16.4 million tons and 54 percent of the world total to 14.9 million tons and 26 percent of the total (tables 1 and 2). This is because of increased wheat production and a subsequent drop in import demand in Western Europe. Japan's average annual imports did increase from 2.3 million to 3.7 million tons.

The central plan area's share of world wheat imports more than doubled during the same period, rising from 15 to 34 percent as a result of large purchases by the Soviet Union and Mainland China. Though large Soviet imports stemmed from poor harvests, Mainland China's imports have been between 4 million and 6 million tons regularly since 1961.

From 1955-57 to 1964-66, average annual imports of the LDC's (mainly South Asia and North Africa) jumped

[4] The International Grains Arrangement definition of a special transaction is "one which whether or not within the price range, includes features introduced by the Government of a country concerned which does not conform with usual commercial practices." According to International Wheat Council compilations, in 1964-66 the less developed area's imports by special transaction averaged 13.3 million tons.

[5] For the most part, U.S. food aid is exported under Public Law 480—the Agricultural Trade Development and Assistance Act.

sharply from 9.5 million to 22.8 million tons; their share of world imports increased from 31 to 40 percent.

The developed exporters accounted for most of the increase in world wheat trade during 1955-57 to 1964-66. U.S. exports more than doubled; Canada's nearly doubled; the EC's were up 130 percent; and Australia's jumped about 120 percent.

Though average annual exports of the less developed area increased from 3.7 million to 5.5 million tons, most of the gain was attributed to Argentina. On a relative basis, this area's exports dropped from 12 to 9 percent of the world total.

The central plan area's exports declined from an average of 3.0 million to 2.6 million tons because of the supply situation in the Soviet Union during 1964-66. At the same time, Eastern Europe's shipments were also down as a result of poor harvests.

From the standpoint of wheat export earnings or import charges, the LDC's suffered a net loss of foreign exchange during 1955-57 to 1964-66. There was no upward trend for export earnings in this area except for Argentina. Mexico, the only other large LDC exporter, adopted a policy of reducing exports (or surplus), since to sell at world prices requires a substantial subsidy because of its higher domestic prices.

Recent Developments

Developments in wheat trade after 1964-66 were highlighted by a drop in the import demand of USSR and South Asia. This has been reflected in a decline in world trade and particularly in U.S. and Canadian exports. The reasons occur mainly on the supply side. Production in the Soviet Union has recovered from the 2 drought years and changes in input use and price policy have given output an additional boost. Production in South Asia has responded very rapidly to technology ("The Green Revolution") in the form of high-yielding semidwarf wheat varieties and larger application of inputs.

Rice

Although rice is the staple food for half of the world's people, less than 5 percent of world production enters international trade. The level of world rice trade is only about 10 percent of world wheat trade. Though traditionally the Asian regions have been dominant in rice trade because they were rice centers, the United States has recently become the leading rice exporter. In fact, the pattern of trade changed markedly during the 1960's (17).

Major Rice Markets and Suppliers

Currently, the major rice-importing countries are in the less developed area, and with the exception of Cuba, they are in Asia. But the major rice exporters are widely scattered about the world.

Although the United States is the leading exporting country, Southeast Asia (Burma, Thailand, Cambodia) is still the major exporting region (table 3). Other less developed exporters include Taiwan, Guyana, Brazil, and the UAR. South Korea, which has been an exporter in some years, has shifted to an import status. In addition to the United States, other developed exporters include Italy, Spain, and Australia. Mainland China is normally the only rice exporter in the central plan area.

Production increases have significantly changed the world rice supply and import demand situation in recent years. Japan has shifted from a net import to a surplus position; West Pakistan is now a surplus producer of IR-8 rice; and the Philippines is self-sufficient.[6] However, import requirements remain substantial in Ceylon, Indonesia, Malaysia, Hong Kong, Singapore, and African countries.

Prior to World War II, Burma was the world's largest exporter of rice, shipping around 3.0 million tons annually. Thailand and French Indochina (Vietnam, Cambodia, and Laos) followed with about 1.3 million and 1.2 million tons, respectively. After World War II, Burma again became the largest rice exporter, shipping between 1.5 million and 2.0 million tons annually in the 1950's and early 1960's, mostly to India, Ceylon and the Philippines. In the mid-1960's, exports from Burma declined and Thailand became the leading exporter. The United States, whose exports were increasing, ranked third and Mainland China, fourth.

In 1967, the leader changed again when the United States became the largest rice exporter, shipping 1.8 million tons. About 40 percent of the total was shipped under P.L. 480, most of which went to South Vietnam. Thailand then ranked second and Mainland China, third. Burma's shipments in the meantime declined to a low of 0.5 million tons.

Production increases in the late 1960's changed the international market situation from a sellers to a buyers market and prices dropped sharply. These developments are of partieular significance for foreign exchange earnings of Thailand, Burma, Cambodia, the UAR, Brazil, and Guyanas. On the other hand, since most of the major rice importers are LDC's, reduced import requirements could free financial resources for other uses.

[6] IR-8 is a high-yielding rice variety developed by the International Rice Research Institute at Los Baños, Philippines. It is a short-stature variety highly responsive to fertilizer.

Table 3.--World rice imports and exports, by region, averages 1954-56, 1959-61, and 1964-66, annual 1967

Region	Exports				Imports			
	1954-56	1959-61	1964-66	1967	1954-56	1959-61	1964-66	1967
	1,000 metric tons							
Developed:								
United States	723	882	1,440	1,853	8	14	15	--
Canada	2	1	6	--	44	41	57	57
EC	308	267	142	244	324	401	393	349
EFTA	5	29	10	--	162	175	232	227
Other Western Europe	64	28	79	146	26	18	23	25
Japan	--	--	--	--	1,147	195	742	517
Australia and New Zealand	35	69	53	93	2	3	5	3
South Africa, Rep. of	--	--	--	--	28	46	69	76
Subtotal	1,137	1,276	1,730	2,336	1,741	893	1,536	1,254
Central plan:								
Eastern Europe	20	12	--	--	177	407	256	262
USSR	7	40	3	--	385	404	283	280
Communist Asia	688	1,327	1,034	1,209	84	52	99	150
Subtotal	715	1,379	1,037	1,209	646	863	638	692
Less developed:								
Latin America	176	175	341	367	249	323	413	475
North Africa	171	157	225	475	14	61	24	36
West Africa	9	13	2	5	210	295	426	315
East Africa	37	42	27	23	129	131	205	248
West Asia	6	1	2	7	232	403	290	342
South Asia	146	73	195	152	1,046	1,362	1,453	1,057
Southeast Asia	3,327	3,544	3,444	2,375	52	37	250	710
Other East Asia	112	150	253	123	408	624	837	1,041
Far East and Oceania	22	3	29	37	1,130	1,821	1,211	939
Subtotal	4,006	4,158	4,516	3,564	3,471	5,057	5,109	5,163
World total	5,858	6,813	7,283	7,109	5,858	6,813	7,283	7,109

Note: Dash indicates no trade or trade of less than 500 metric tons.

Source: Compiled from (89).

Table 4.--Regional share of world rice imports and exports, averages 1954-56, 1959-61, and 1964-66, annual 1967

Region	Exports				Imports			
	1954-56	1959-61	1964-66	1967	1954-56	1959-61	1964-66	1967
	Percent							
Developed:								
United States	12.3	13.0	19.8	26.1	0.1	0.2	0.2	--
Canada	--	--	0.1	--	0.8	0.6	0.8	0.8
EC	5.3	3.9	2.0	3.4	5.5	5.9	5.4	4.9
EFTA	0.1	0.4	0.1	--	2.8	2.6	3.2	3.2
Other Western Europe	1.1	0.4	1.1	2.1	0.4	0.3	0.3	0.3
Japan	--	--	--	--	19.6	2.8	10.2	7.3
Australia and New Zealand	0.6	1.0	0.7	1.3	--	--	0.1	--
South Africa, Rep. of	--	--	--	--	0.5	0.7	0.9	1.1
Subtotal	19.4	18.7	23.8	32.9	29.7	13.1	21.1	17.6
Central plan:								
Eastern Europe	0.4	0.2	--	--	3.0	6.0	3.5	3.7
USSR	0.1	0.6	--	--	6.6	5.9	3.9	3.9
Communist Asia	11.7	19.5	14.2	17.0	1.4	0.8	1.4	2.1
Subtotal	12.2	20.3	14.2	17.0	11.0	12.7	8.8	9.7
Less developed:								
Latin America	3.0	2.6	4.7	5.2	4.2	4.7	5.7	6.7
North Africa	2.9	2.3	3.1	6.7	0.2	0.9	0.3	0.5
West Africa	0.2	0.2	--	0.1	3.6	4.3	5.8	4.4
East Africa	0.6	0.6	0.3	0.3	2.2	1.9	2.8	3.5
West Asia	0.1	--	--	0.1	4.0	5.9	4.0	4.8
South Asia	2.5	1.1	2.7	2.1	17.9	20.0	20.0	14.9
Southeast Asia	56.8	52.0	47.3	33.4	0.9	0.6	3.4	10.0
Other East Asia	1.9	2.2	3.5	1.7	7.0	9.2	11.5	14.6
Far East and Oceania	0.4	--	0.4	0.5	19.3	26.7	16.6	13.2
Subtotal	68.4	61.0	62.0	50.1	59.3	74.2	70.1	72.6
World total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Dash indicates no trade or trade of less than 500 metric tons.

Source: Computed from data in table 3.

Over the past two decades, the developed area has switched from a net import to a net export position. In 1967, its rice exports totaled 2.3 million tons and its imports, 1.3 million tons (table 3). This accounted for one-third of world exports and 18 percent of world imports (table 4). In comparison, 1951 exports of 774,000 tons and imports of 1.3 million tons accounted for 16 percent of world exports and 27 percent of imports. The United States accounted for three-fourths of the developed area's exports in 1967. Japan has been the most important rice importer of the developed countries. However, with bumper crops in 1967 and 1968, Japan shifted to a surplus position. The EC, EFTA, and South Africa then became the major markets in the developed area.

Rice trade in the less developed area has been very volatile in recent years. Burma's exports have dropped drastically and South Vietnam has shifted from an exporter to an importer. The Philippines have switched from a net importer to a position of self-sufficiency. In 1969, shipments from West Pakistan included over 350,000 tons of IR-8 rice to East Pakistan and over 100,000 tons of Basmati, mostly to markets in the Middle East. Exports from the UAR advanced sharply in the 1960's. Import requirements of West Africa and South Africa have moved up sharply over the past two decades. Exports of Latin America have fluctuated upward, while their import requirements have moved down.

In 1967, the central plan countries accounted for 17 percent of world exports and 10 percent of world imports (table 4). Their relative position in world rice trade has fluctuated sharply over the past two decades. In 1951, they accounted for 3 percent of world exports and 2 percent of world imports; in 1959, they accounted for 29 percent of exports and 17 percent of imports. Mainland China accounts for virtually all exports and the USSR and Eastern Europe are normally importers.

Coarse Grains

World exports of the major coarse grains nearly doubled during the first 7 years of the 1960's, rising from 22.3 million tons in fiscal 1960 to 43.8 million tons in fiscal 1966. However, exports then declined about 10 percent to an estimated 39.4 million tons in fiscal 1969 as a result of increased production of coarse grains in importing countries and expanded use of wheat and other feedstuffs in livestock rations.

Nine countries—the United States, Argentina, France, South Africa, Brazil, Canada, Mexico, Thailand, and Australia—accounted for 80 to 88 percent of world coarse grain exports during the 1960's. Although the United States has been the dominant international supplier, other producers shared in the market growth during the decade. Among LDC exports, those of Argentina increased from 4 million tons in 1960 to 5.6 million in 1969; Thailand's rose almost continuously to 1.3 million tons in 1969; Mexico's increased from 0.4 million to 1.0 million tons in 1969; and Brazil's, which were virtually nil at the start of the decade, reached a high of nearly 1.2 million tons in 1969. Other LDC's, located principally in East Africa and Southeast Asia, have exported significant quantities of coarse grains in recent years.

Corn is the most important coarse grain in world trade. With corn exports rising sharply from 12 million to 27 million tons during the 1960's, corn's share of the coarse grain market jumped from about one-half to two-thirds. Barley is the second leading coarse grain traded, though its share of trade dropped throughout most of the decade. Sorghum exports increased, keeping abreast with the growth of corn *(139)*.

Major Markets and Suppliers

The developed countries were the major coarse grain markets in the 1950's and 1960's. Because of increased affluence in these countries, demand for high-protein livestock food products has expanded rapidly; this expansion, in turn, has led to increased feed requirements from both domestic and foreign suppliers. Western Europe and Japan accounted for 70 percent of the trade in 1951-53 and 80 percent in 1963-65. The developed countries are also the major coarse grain exporters, accounting for approximately two-thirds of the world total.

EC.—Until recently, the EC has been the world's largest coarse grain importer. Imports in 1963-65 averaged 14.3 million tons, accounting for over 40 percent of world coarse grain trade (tables 5 and 6). The LDC's, primarily Argentina, supplied 20 to 40 percent of this. In the early 1950's, North Africa and West Asia were fairly significant suppliers, but by the late 1960's EC imports from these regions had declined to low levels. Canada, likewise, was a fairly important supplier that slipped after 1953. The United States has become an important supplier, accounting for around half of the Common Market's import requirements during the 1960's.

Not only is the EC the world's largest importer, but it is also the third largest exporter. This is partly due to intra-Community trade, which increased sharply in the 1960's. By 1965, it was more than 2 million tons a year. It has accounted for 40 to 50 percent of total EC exports.

Total EC coarse grain exports grew from 127,000 tons in 1961 to nearly 4.5 million in 1965. The primary

grain exported was barley, and France was by far the Community's largest exporter. Exports of grains and grain products from the EC to non-EC nations would not be possible without subsidy, since EC domestic prices are much higher than world prices. This is accomplished under the EC Common Agricultural Policy (CAP) in the form of export payments. The payments are uniform for the whole Community, but are differentiated according to country of destination so EC grain will be competitive.

United Kingdom.—During 1951-57, average coarse grain imports by the United Kingdom ranged from 2.5 million to 3.0 million tons. Imports jumped to 4.4 million tons in 1958 and remained above 4 million through 1965. Both the quantity and the proportion imported from the LDC's declined during 1958-65. Latin America held its own but there were large declines for North Africa and West Asia. The United States was the largest supplier after 1953, accounting for as much as 60 percent of the U.K. market. Canada's share of the market generally declined after 1955.

Other Western Europe[7].—Other Western Europe has been an important and growing import market for coarse grains. During 1951-65, imports ranged from 1.6 million to 5.5 million tons. Imports increased about 7 percent annually. The developed countries supplied 60 to 80 percent of these imports and the LDC's, 10 to 20 percent. The United States was by far the major supplier and since 1960, the EC has been a significant supplier.

The major importers in this region are Denmark, Spain, Switzerland, and Austria. Sweden has been a net exporter—shipping mostly barley and oats. Denmark exported barley but was still a net coarse grain importer. Portugal was a net exporter of corn until 1959. During the 1950's and 1960's, the trend in imports by Ireland and Sweden was downward. For Denmark, imports declined in 1962-66.

Japan.—Imports of coarse grains by Japan have accelerated at such a rate that by the late 1960's, Japan was the largest country market in the world. In some years, a substantial proportion of Japan's imports came from LDC's, but the majority of its imports came from the developed area, mainly the United States. However, there has been a trend toward importing more from the LDC's, primarily Thailand. With the backing of the Government, trading firms in Japan have made commitments to purchase coarse grains from Southeast Asia and Oceania. In effect, the Government, through the trading firms, is establishing preferential import allocations for coarse grains from the countries involved.

United States.—Nearly 47 percent of the coarse grains entering world trade in 1963-65 originated in the United States (table 6). From 1951 to 1965, U.S. exports on trend increased over a million tons a year, nearly 11 percent annually. Almost all of the increase was to developed nations, including Japan, the EC, EFTA, and Other Western Europe (primarily Spain). Except for exports to Japan, which continue to increase, U.S. exports to these regions have fallen off since the mid-1960's. The proportion of U.S. exports shipped to the LDC's has declined slightly.

Australia and South Africa.—As a group, these southern hemisphere countries are the third largest coarse grain exporters in the world. Their shipments have grown at a moderate rate. The major destinations of their exports are the EC, especially Italy and Germany; the United Kingdom; and Japan.

South Africa's major coarse grain export is corn, but grain sorghum is growing in importance. Australia's major export is barley followed by oats.

Canada.—Canadian coarse grain exports declined 56 percent between 1951-53 and 1963-65. In 1951-53, Canada was second only to the United States as an exporter, but in 1963-65 it was seventh among the regions in this study (table 5). Nearly all of the decrease resulted from a drop in trade with the United States. Exports to Japan dropped, but Japan's share of Canada's exports remained about the same. The EC and EFTA took 37 percent of Canada's exports in 1951-53, but they accounted for 63 percent in 1963-65.

USSR.—Traditionally an exporter, the USSR has imported small quantities from time to time. In 3 of the 5 years, 1960-65, USSR coarse grain exports were over 2 million tons. Practically all exports went to European nations.

Eastern Europe.—This region is a net importer of coarse grains. During 1954-61, imports fluctuated around 1.7 million tons annually. During next 4 years, annual imports moved to a plateau of about 3.0 million tons. The USSR has been Eastern Europe's major supplier, filling between one-third and two-thirds of its deficit. Latin American nations have occasionally supplied as much as one-fourth of the supply, but usually LDC's have not been major suppliers. Imports from the developed area have fluctuated widely; the United States usually has been the primary supplier from this area. There is a substantial amount of intraregional trade in Eastern Europe, usually from the southern to the northern countries.

Latin America.—Latin America is both an importer and an exporter of coarse grains, though imports are relatively small. The trend of exports in 1951-65 was upward at 250,000 tons, or roughly increasing 8 percent a year. The largest market was the EC, which

[7] Includes Austria, Cyprus, Denmark, Finland, Greece, Iceland, Ireland, Malta, Norway, Portugal, Spain, Sweden, and Switzerland.

Table 5.--World coarse grains imports and exports, by region, averages 1951-53 and 1963-65

Region	Exports		Imports	
	1951-53	1963-65	1951-53	1963-65
	1,000 metric tons			
Developed:				
United States	4,817	16,155	1,678	189
Canada	3,198	1,390	154	373
EC	187	3,833	4,787	14,302
United Kingdom	91	187	2,771	4,150
Other Western Europe	313	541	1,923	4,808
Japan	33	--	976	4,657
Australia, New Zealand, and South Africa Rep. of	729	2,102	99	2
Subtotal	9,369	24,208	12,389	28,482
Central plan:				
Eastern Europe	664	1,406	740	3,113
USSR	1,178	2,044	--	--
Communist Asia	280	151	--	--
Subtotal	2,122	3,601	740	3,368
Less developed:				
Latin America	1,419	4,767	278	853
North Africa	690	316	54	307
West Africa	100	97	25	109
East Africa	99	142	126	159
West Asia	831	447	141	663
South Asia	--	79	618	143
Southeast Asia	61	964	--	16
Other East Asia	11	9	308	361
Far East and Oceania	7	2	32	169
Subtotal	3,218	6,822	1,582	2,781
World total	14,709	34,631	14,705	34,632

Note: Dash indicates no trade or trade of less than 500 metric tons.

Source: Computed from tables 39-41 and 51-53 in (89).

Table 6.--Regional share of world coarse grains imports and exports, averages 1951-53 and 1963-65

Region	Exports		Imports	
	1951-53	1963-65	1951-53	1963-65
	Percent 1/			
Developed:				
United States	32.6	46.6	11.4	.5
Canada	21.7	4.1	1.0	1.1
EC	1.3	11.1	32.6	41.3
United Kingdom	.6	.5	18.8	12.0
Other Western Europe	2.1	1.6	13.1	13.9
Japan	.2	--	6.6	13.4
Australia, New Zealand, and South Africa Rep. of	4.9	6.1	.7	--
Subtotal	63.4	69.9	84.3	82.2
Central plan:				
Eastern Europe	4.5	4.1	5.0	9.0
USSR	8.0	5.9	--	--
Communist Asia	1.9	.4	--	.7
Subtotal	14.4	10.4	5.0	9.7
Less developed:				
Latin America	9.6	13.8	1.9	2.5
North Africa	4.7	.9	.4	.9
West Africa	.7	.3	.2	.3
East Africa	.7	.4	.9	.5
West Asia	5.6	1.3	1.0	1.9
South Asia	--	.2	4.2	.4
Southeast Asia	.4	2.8	--	--
Other East Asia	.1	--	2.1	1.0
Far East and Oceania	--	--	.2	.5
Subtotal	22.2	19.7	10.6	8.0
World total	100.0	100.0	100.0	100.0

Note: Dash indicates no trade or trade of less than 500 metric tons.

1/ Percentages may not add to 100 because of rounding.

Source: Computed from data in table 5.

usually accounted for more than one-half of total exports. Since 1965, EC corn imports have continued upward but the proportion obtained from Argentina has declined. Typically, only 2 or 3 percent of Latin American exports go to other LDC's; most of this to countries within Latin America.

During 1961-66, Argentina accounted for about three-fourths of coarse grain exports from Latin America. About 70 percent of Argentina's coarse grain exports were corn. Mexican and Brazilian corn exports became very sizable in the early and mid-1960's.

South Asia.—South Asia's imports of coarse grains have been largely from the United States under P.L. 480. In the early 1950's, some coarse grain was imported from Australia and South Africa but these sources have not been important in recent years.

North Africa.—During the early 1950's, North Africa was a net exporter of coarse grains. By the mid-1960's, imports were about equal to exports. Most exports went to the developed nations.

Southeast Asia.—Thailand is the major coarse grain exporter in this region. The growth rate in Thailand's exports has been extremely high, primarily because of a policy to increase corn production and the contractual arrangement with Japan.

III.—TRADE POLICIES

A realistic evaluation of import demand for grains must take into account any regulations on trade flows. In other chapters, the demand effects of factors such as incomes and prices are analyzed. But trade may be a necessary source of supply to fulfill demand. Hence, projections of trade that are made within a supply-demand framework must also consider the influence of trade policies.

A common objective of most commodity trade policies throughout the world is price stabilization. Most often the effort is directed to producer prices, but for some importing countries, policies may be geared to consumer prices as well. Policies can be either restrictive or stimulative to trade. Implementation of trade policies takes on many forms—tariffs, levies, quotas, embargoes, standards and grades, subsidies, and concessions on terms of trade. In addition, there are international commodity agreements, including the International Wheat Agreement (IWA).

Agricultural Import Barriers[8]

This section draws on project research on trade policies of selected countries in the developed area (12).[9] It is basically descriptive and does not assess the effects of these countries' trade barriers. The effect of the barriers is taken into account in the mathematical projection model discussed in chapter IV.

The import trade barriers are outlined in table 7 and are discussed below by type of grain and country, and, in some cases, their "height" is evaluated. Even though import quotas of a very large size offer little protection, they are inherent handicaps to trade because they can be easily reduced by administrative action. Therefore, it is useful to know the size of import quotas by country and grain so that comparisons of quota size can be made between countries and over time.

To make such comparisons on a more meaningful basis than tonnages alone, a list of quotas by country can be conformed to reflect differences in country size. No method of making such an adaptation is ideal, but at least two methods seem to be acceptable. First, quota size can be related to the size of a country's economy or aggregate demand for goods and services by dividing quota tonnages by gross national product (GNP), national income, or private consumption expenditures. For example, if country A's quota on imports of commodity X were 10,000 tons, and its GNP $90 billion, the quota per billion dollars GNP would be 111.1 tons. Second, quota size can be related to population by dividing quota tonnages by population—this is a conventional method that uses a per capita base. For example, if country A's quota on imports of commodity Y were 140,000 tons, and its population 50 million, the quota would be 2.8 kilograms per person. The two methods permit intercountry or temporal comparisons of quota sizes for the same commodity, but they do not allow intercommodity comparisons.

For simplicity, the second method—import quotas per capita—is used in this report. The objective here is a simple expression of the intuitive conclusion that for commodity Z, a Japanese quota of 25,000 tons is not really equivalent to a Greek quota of the same tonnage.

[8] This section was prepared by Joseph R. Barse, Foreign Develop. and Trade Div., ERS.

[9] Surveyed in this section are the United States, the EC, Japan, the United Kingdom, Denmark, Finland, Ireland, Norway, Sweden, Switzerland, Austria, Portugal, Spain, Greece, Canada, Australia, New Zealand and the Republic of South Africa. Unless noted otherwise, the time period is the late 1960's.

The "height" of a trade barrier is the amount of quota (in kilograms per capita), the ad valorem rate of a tariff, or the ad valorem equivalent rate of a specific duty.[10] By definition, the higher the tariff rates or the smaller the quota per capita, the "higher" the trade barrier. For comparability, all specific duties were converted into dollars per ton (at par value exchange rates of 1969), regardless of the units in which these duties were stated in national tariff schedules. However, a trade barrier's height is merely descriptive, and such a description does not imply an assessment of possible restrictive effect on trade volume.

A state trading agency or a governmental import monopoly may encompass the concepts of both tariff and quota, as well as normal marketing functions, such as purchase, storage, transport, and sale. Therefore, a government import plan is a quantitative regulation or a quota if import purchase decisions are exclusively in government hands. Though government import plans are frequently revised as a year progresses, they may be viewed as a de facto annual quota.

State trading implies that a government monopoly takes title to shipments at the point of importation. Taking title and reselling by the monopoly may be almost instantaneous, or the monopoly may retain title to the imported goods and store them.

Moreover, the commodities may also be transported at government expense while under monopoly ownership. As a result, at the time the government monopoly sells the imported goods to wholesalers on the domestic market, it may be difficult to determine how much of the state trading price markup is attributable to storage, transport, and normal marketing functions, and how much to a partly concealed import tax. Such a tax, or "skimming," is analogous to a specific tariff or other tax paid on importation, and can be converted to an ad valorem equivalent tariff levied upon the c.i.f. price at which the monpoly took title to the commodity.

In most of the entries in table 7, the countries of the European Community are considered as a regional aggregate, since they have a Common External Tariff and a Common Agricultural Policy. The common policy arrangements for wheat, rice, and coarse grains are highly complex. The tables in this chapter refer only to the portion of each common policy which is a trade barrier in a formal sense. It is acknowledged that the trade barrier portion of a common market regulation is highly interdependent upon other parts of the same regulation.

[10] In the case of an embargo, the term "no quota" is not used because it would not be clear whether it referred to "no quantitative regulation" or conversely "import embargo." However, the term "zero quota" is used to mean "de facto embargo."

Wheat

Of the 18 countries surveyed (the EC is classified as one country), 15 maintained quantitative regulation of wheat imports in the form of tonnage quotas, state trading, or embargoes (table 7). The EC, the United Kingdom, and Sweden did not have these quantitative regulations. Switzerland assigns the amount of domestic wheat to be used for food milling, making import needs for food wheat a residual amount. In addition, Switzerland employs a direct quota on total imported feedstuffs to control imports of feed wheat.

The presence of wheat import embargoes in traditional exporting countries such as Australia and Canada is not surprising, though the severe wheat import regulations of Spain and Denmark seem unusual for countries which are not major exporters.

In 1969-70, the variable levy on wheat in the EC was equivalent to an 89-percent tariff (annual average). The Swedish tariff equivalent was 86 percent (table 9). The United Kingdom's deficiency payment system is a way of insulating returns to U.K. farmers from world market prices. The deficiency payments also permit British wheat offered domestically to undercut U.K. import prices (c.i.f. plus inland transport and storage) of comparable foreign wheats. Normally, this could be done even without the small variable levy on wheat imports which was imposed from time to time.

International trade in wheat has been subject to special trading agreements almost continuously since 1949. The first International Wheat Agreement (IWA) was effected on August 1, 1949, and its successor, the International Grains Arrangement, became effective on July 1, 1968, for a duration of 3 years. The IGA consists of two legal instruments—a Wheat Trade Convention and a Food Aid Convention.[11] The Wheat Trade Convention, which is a stabilizing instrument, prescribes a price range for international trade. The Food Aid Convention commits participating countries to contribute wheat, coarse grains, or the cash equivalent as aid to less developed countries to an amount of 4.5 million tons annually.

International commodity agreements have met with varying degrees of success and the IGA and its predecessor are no exceptions.[12] The price levels of the IGA have failed to hold up under world supply and demand situations and have been well below the established minimums.

A new International Wheat Agreement was concluded in Geneva on February 20, 1971, to replace the expiring IGA. The IWA, like the IGA, is a 3-year pact containing

[11] For a fuller discussion of the IGA, see (75) and (147).

[12] For a discussion on International Commodity Arrangements and Policies see (20).

a Wheat Trade Convention (WTC) and a Food Aid Convention (FAC). The WTC provides for member cooperation or consultation on supply and prices by establishing an Advisory Subcommittee on Market Conditions. It does not, however, contain any price provisions such as the minimums and maximums under the IGA. The new FAC is similar to the IGA. The IWA is effective July 1, 1971, subject to ratification by member governments.

Rice

Of the countries surveyed, six employed quotas as the main device for regulating rice imports, while nine (the United States, the EC, the United Kingdom, Denmark, Finland, Switzerland, Austria, Canada, and Australia) employed only a tariff or import tax on rice imports (table 7). Only three countries—Ireland, Sweden, and New Zealand—had no barriers against rice imports.

All specific tariffs on rice were converted to ad valorem equivalents under specified c.i.f. price assumptions and arrayed in table 9. The tariff rate equivalents ranged from a high of 65 percent in the EC to a low of 7 percent in Canada. Preferential tariffs for rice by country of origin are used in the EC, the United Kingdom, Portugal, and Australia, while preferential quotas by country of origin are employed by the EC and Greece.

Coarse Grains

Quantitative regulation of barley, corn, and grain sorghums is almost as widespread as that of wheat. Import quotas are used not just by the traditional exporting countries, but also by importing nations desiring to protect domestic producers from world competition. For example, in 1969, Spain reimposed severe quotas—embargoes—on imports of corn and grain sorghums after several quota-free years.

In 1968-69, rates of ad valorem duty or tariff equivalents on feed grains ranged from a high of about 123 percent on corn and barley at Swedish ports to a low of about 2 percent in the United Kingdom (variable levy) (table 9). However, this low tariff equivalent of the U.K. levy is deceptive because it must be read in conjunction with the price-preference effects of the U.K. deficiency payment system. The variable levy on corn for the EC in 1969-70 was equivalent to a 57-percent tariff (annual average).

Japan employs a complex tariff quota on corn and sorghums for nonfeed industrial use, and generalizing about Japanese feed grain import barriers is thus more difficult. Import barriers of different heights according to different end use of a standard commodity are, in a way, analogous to the different barrier heights maintained according to country origin of a commodity. State trading organizations of Austria, Portugal, and South Africa may purchase coarse grains with clear preference for certain favored countries of origin.

General Trade Policies: Japan

Thus far, discussion has been focused on policies in effect for specific grains. But economic policies of a more general nature can also have a substantial effect on commodity trade. An example was included in a study concerned with the effects of alternative food strategies on the future development of food consumption patterns in Japan (11). The study found that Japanese food consumption per person in the 1960's was lower than in any comparable developed country, even though Japan has experienced very rapid growth in consumer income since the 1950's. This lower consumption was due primarily to Japan's limited agricultural production and to quotas on imports of processed foods. Consumption of livestock products was especially low, because Japan's livestock sector was developing from a low level of resource use.

To indicate the possible influence of food strategy on consumption patterns in Japan over the next 15 years, the study set forth three of many alternative strategies that Japan could adopt: (1) a Western food strategy, (2) a Pacific food strategy, and (3) an Eastern food strategy. Each strategy was discussed in terms of domestic and import planning targets for food and food raw materials, such as livestock feed grains. Under the Eastern food strategy, present consumption patterns and import policies would hold imports of wheat and coarse grains to only moderate increases. The Western food strategy, at the other extreme, would seek a Western diet and imply a very high level of agricultural imports. For example, imports of feed grains in the 1980's might range from 12.4 million tons under the Eastern food strategy to 40.8 million under the Western food strategy. Because massive food and feed imports entail special risks, it is not surprising that Japan has already initiated a policy to reduce its dependency on a few major suppliers by encouraging countries in Southeast Asia and East Africa to also become important supplies of feed grains. The extent of Japan's encouragement to them is a crucial food-strategy issue for the future.

Table 7.--Trade barriers to grain imports in developed countries

Commodity	Country		
	United States	European Community	Japan
Wheat	TARIFF: GATT: For food: $7.72 m.t.; Not food: 5%. 1930 Act: For food: $15.43 m.t.; Not food: 10%. $7.72 per m.t. is 15% when wheat is $51 per metric ton. GLOBAL QUOTA (tonnage): Sec. 22, 800,000 bu. (21,800 metric tons)	VARIABLE LEVY: In 1969-70, the average levy on wheat was about $58 per metric ton, equivalent to an 89% tariff for a cargo priced at $65 per ton c.i.f. EC ports, a representative price that year.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): '69 quota 4.3 million m.t. Markup is storage + handling + "skimming" tariff. Example '69 skimming: About $18 m.t., 24% equivalent for wheat $75 ton c.i.f. Japan.
Rice	TARIFF: Rough: $27.56 per metric ton. Brown: $33.07 per metric ton. Milled: $55.12 per metric ton. $55.12 is 31% when milled rice is $176 per metric ton.	VARIABLE LEVY: Averaged $142 m.t. milled long-grain 1969-70, a 65% equivalent, since EC c.i.f. price averaged about $220 m.t. 1969-70. PREFERENTIAL LEVY QUOTA for African Associates, other overseas: 45% levy discount on 105% prior trade volume.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): '69 quota 50,000 m.t. Varies widely year to year. Example of markup in '68: About $105 m.t. on milled short grain at $200 ton c.i.f. Japan, about 53% equivalent.
Barley	TARIFF: GATT: $3.44 m.t. 1930 Act: $9.19 m.t. $3.44 per m.t. is 6% when barley is $55 per metric ton.	VARIABLE LEVY: In 1969-70, the average levy on barley was about $50 per metric ton, equivalent to 102% tariff for a cargo priced at $49 per ton c.i.f. EC ports, a representative price that year.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Markups for feed barley $11.00 per m.t. in '68, about 18% when barley $60 m.t. c.i.f. Total quota all barley about 630,000 m.t. 1968.
Corn	TARIFF: GATT: $3.95 m.t. 1930 Act: $9.83 m.t. Preferences for Cuba are suspended. $3.95 per m.t. is 8% when corn is $47 per metric ton.	VARIABLE LEVY: In 1969-70, the average levy on corn was about $36 per metric ton, equivalent to a 57% tariff for a cargo priced at $63 per ton c.i.f. EC ports, a representative price that year.	Feed corn: No tariff or quota. TARIFF QUOTA: Industrial corn: Type: For Starch; Other. Quota: 0.4 mil. m.t.; 0.5 mil. m.t. In quota: Free; 10%. Over quota: $24 m.t.; $24 m.t. $24 m.ton 40% equiv. at $60 c.i.f.
Grain sorghums	TARIFF: GATT: $8.82 m.t. 1930 Act: $44.09 m.t. $8.82 per m.t. is 20% when grain sorghum is $44 per metric ton.	VARIABLE LEVY: In 1969-70, the average levy on grain sorghums was about $37 per metric ton, equivalent to a 65% tariff for a cargo priced at $57 per ton c.i.f. EC ports, a representative price that year.	Feed sorghum: No tariff or quota. TARIFF QUOTA: Industrial sorghum. Within quota: Free. Over quota: 5%. 1968 free quota about 4,000 metric tons.
Sources	Tariff Schedules of the United States (annotated), 1969; Agricultural Policies in 1966, OECD; U.S. Import Duties on Agricultural Products, 1968, Agriculture Handbook 368, FAS, USDA, 1970.	Berntson B., O.H. Goolsby and C.O. Nohre, The European Community's Common Agricultural Policy, FAER-55, ERS, USDA; Agrarmärkte, Preise, Nos. 6 and 7, 1970, Directorate General for Agriculture, EC; Council Regulation 540/70, Amtsblatt No.L68, March 25, 1970.	U.S. Agricultural Attache Reports, Tokyo, Numbers AGR-350 (June 1964), AGR-159 (June 1966), AGR-84 (Feb. 1967), AGR-55 (Oct. 1967), JP8121, JP8153, JP8190, JP8191, JP9030; World Wheat Statistics, 1969, IWC; Mitsui's Grain reports, various.

Continued--

Table 7.--Trade barriers to grain imports in developed countries (continued)

Commodity	Country		
	United Kingdom	Ireland	Denmark
Wheat	PRICE PREFERENCE TO DOMESTIC WHEAT undercuts price similar import wheat. Assured by farm direct payments. Mills pledge use UK wheat 1,500,000 m.t. Intermittent VARIABLE LEVY, example $1.80 m.t., 3% equiv.; apply if need force up price foreign wheat.	IMPORT LICENSES required, issued to assure domestic wheat about 75% of food milling. De facto GLOBAL TONNAGE QUOTA, 100,000 m.t. for food, 1969. QUOTA for feed wheat or sorghums (depending on price) was 170,000 m.t. TARIFF: $7 m.t. for food	MILLING MIXTURE REGULATION: Normally, 100% domestic wheat, a de facto import embargo enforced by: IMPORT LICENSE REQUIREMENT. VARIABLE LEVY: When feed wheat allowed, about $20 m.t. in 1969, 29% equiv. when wheat $68 m.t. c.i.f.
Rice	TARIFF: Commonwealth: milled and brown: Free; Full & EFTA: $11.22 per metric ton (8% equiv.): milled: Free; brown: Free. 1972 rate: $7.08 per metric ton	Import licenses freely available (1968-69), but issued selectively in 1966.	TARIFF: Rough: Free; Brown: Free; Milled: 5%
Barley	TARIFF: Commonwealth: Free; Full & EFTA: 10%. VARIABLE LEVY: Often triggered, removed. Example, $3.60 m.t., 7% when barley c.i.f. $52 m.t., 1969. PRICE PREFERENCE TO DOMESTIC BARLEY due to tariff, levy, direct payments.	IMPORT LICENSES required, granted by Grain Board. De facto GLOBAL TONNAGE QUOTA, about 25,000 metric tons in 1969.	IMPORT LICENSE REQUIREMENT permits official IMPORT EMBARGO during all 1969, but actual imports, de facto QUOTA, 15,700 m.t. 1969. VARIABLE LEVY: If imports allowed, about $26 m.t. 1969, 54% equiv. if barley $48 m.t. c.i.f.
Corn	TARIFF: Flat white only: 10%, Full & EFTA; VARIABLE LEVY: Any corn: Often triggered, removed, as $1.20 m.t., 2% when corn $54 m.t. c.i.f. PRICE PREFERENCE TO DOMESTIC BARLEY, due to levy and farm direct payments, constitutes barrier to corn also.	IMPORT LICENSES required, granted by Grain Board. De facto GLOBAL TONNAGE QUOTA, about 125,000 metric tons in 1969. IMPORT TAX: $2.40 m.t. 1968, 5% equivalent when corn is $50 m.t. c.i.f.	IMPORT LICENSE REQUIREMENT employed to embargo corn part 1970. VARIABLE LEVY: But, LEVY-FREE QUOTA, up to 100,000 m.t. corn in 1969 if matching amount Danish grain exported. Over-quota levy $10 m.t. 1969, 17% equiv. if corn $58 m.t. c.i.f.
Grain sorghums	TARIFF: Commonwealth: Free; Full & EFTA: 10%. VARIABLE LEVY: Rarely triggered. PRICE PREFERENCE TO DOMESTIC BARLEY, due to tariff and farm direct payments, which allow barley prices to undercut grain sorghum prices.	IMPORT LICENSES required, granted by Grain Board. De facto GLOBAL TONNAGE QUOTA. Quota normally for grain sorghums or feed wheat; which bought depends on prices. But 1968-69, sorghums only. About 170,000 metric tons in 1969.	IMPORT LICENSE REQUIREMENT permits IMPORT EMBARGO during all 1969. LEVY-FREE QUOTA combined with corn in 1968, but no such quota for sorghums in 1969. Over-quota VARIABLE LEVY: $15 m.t. in 1968, 29% equivalent if sorghums $52 m.t. c.i.f.
Sources	Schertz, Lyle, Cereal Policies in the U.K., 1870-1967, FAR-130, FAS, USDA; Report on the Agricultural Trade Negotiations of the Kennedy Round, FAS-M-193, USDA; U.S. Agricultural Attache Reports, London, Numbers UK8371, UK9085, UK9119, UK9134, UK9073, and letters.	U.S. Agricultural Attache Reports, Dublin, Numbers AGR-91 (May 23, 1967), AGR-72 (Dec. 28, 1967), AGR-73 (Dec. 28, 1967), AGR-97 (Feb. 7, 1968), IL9026, and letters.	U.S. Agricultural Attache Reports, Copenhagen, Numbers AGR-45 (Jan. 9, 1968), DN8114, DN8122, DN9004, DN9007, DN9028, DN0022, and letter; International Customs Journal, Denmark (1965), as updated in FAS, USDA.

Continued--

Table 7.--Trade barriers to grain imports in developed countries (continued)

Commodity	Country		
	Norway	Sweden	Finland
Wheat	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Total quota: about 316,000 m.t. 1968, markup about: $26 m.t. '68, 39% equiv. when wheat $67 ton c.i.f. Norway. Nordic Union '69 leads to: PREFERENTIAL QUOTAS TO SWEDEN, DENMARK.	VARIABLE LEVY: Example of 1969 levy about $66 per metric ton, 86% equivalent if wheat $77 m.t. c.i.f. Swedish ports.	MILLING MIXTURE REGULATION, about 90% domestic for 1969, plus IMPORT LICENSING: Together a de facto IMPORT QUOTA system, in 1969 about 19,100 m.t. Bilateral agreement with USSR, PREFERENTIAL QUOTA for Soviet wheat, about 15,000 m.t. 1970.
Rice	GLOBAL VALUE QUOTA: 1.3 million kroner ($182,000) administered by Ministry of Commerce. Equivalent to almost 1,100 m.t. if rice priced at $170 ton c.i.f. Norway.	Free	IMPORT TAX, in 1969: Brown: $50.00 per metric ton Milled: $107.00 per metric ton
Barley	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Total quota about 94,000 m.t. feed barley, 1967. Markup about $29 m.t. 1967, 47% equivalent when barley $61 ton c.i.f. Norway. Malting barley not state traded.	VARIABLE LEVY: Example of 1969 levy about $70 per metric ton, 123% equivalent if barley $57 m.t. c.i.f. Swedish ports.	IMPORT TAX: $59.52 per metric ton in 1969. IMPORT LICENSE REQUIREMENT: De facto IMPORT EMBARGO 1969.
Corn	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Total quota about 89,000 m.t. 1968. Markup about $39 m.t. 1968, 67% equivalent when corn $58 ton c.i.f. Norwegian ports. Quotas vary widely year to year.	VARIABLE LEVY: Example of 1969 levy about $75 per metric ton, 123% equivalent if corn $61 m.t. c.i.f. Swedish ports.	VARIABLE LEVY: About $35.70 m.t. 1969, 55% equiv. if corn $65 m.t. c.i.f. Finland. No levy if for certain industrial processing. De facto IMPORT QUOTA by licensing, about 13,900 m.t. 1969.
Grain sorghums	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Total quota about 150,000 m.t. 1968. Markup about $30 m.t. 1968, 51% equivalent when grain sorghums $59 ton c.i.f. Norwegian ports. Quotas vary widely year to year.	VARIABLE LEVY: Example of 1969 levy about $68 per metric ton, 121% equivalent if sorghums $56 m.t. c.i.f. Swedish ports.	IMPORT TAX: $23.80 per metric ton in 1969.
Sources	U.S. Agricultural Attache Reports on Norway from Copenhagen, Denmark, Numbers AGR-3 (Aug. 11, 1967), NR8016, NR9004, NR9013, and letter.	U.S. Agricultural Attache Reports, Stockholm, Numbers AGR-44 (Feb. 10, 1967), AGR-4 (Aug. 15, 1967), SW8044, SW9006, and letter.	National Grain Policies, 1969, FAO; Schertz, L. and K. Neeley, Barriers to International Grain Trade, FAR-126, FAS, USDA; U.S. Agricultural Attache Reports, AGR-6 (Sept. 15, 1967); Letter from U.S. Embassy, Helsinki.

Continued--

Table 7.--Trade barriers to grain imports in developed countries (continued)

Commodity	Country		
	Switzerland	Austria	Portugal
Wheat	DOMESTIC PREFERENTIAL QUOTA: Gov't. sets amount Swiss wheat for milling, 311,000 m.t. '68. Rest of mill needs from imports, 333,000 m.t. 1968. TARIFF PLUS SURCHARGES: $16.50 m.t. 1968, 21% if wheat $80 c.i.f. Feed wheat to feedstuffs quota.	STATE TRADING (TONNAGE QUOTAS MAY SPECIFY COUNTRY ORIGIN; VARIABLE SKIMMING LEVY ON ENTRY): Preference to Canada. 1968 quota 16,000 m.t. A 1968 skimming rate on Canadian durum ($88 m.t. c.i.f. border) was $14, 16% equivalent.	STATE TRADING (TONNAGE QUOTA PLUS PRICE MARKUPS ON RESALE): Total import target for year by Nat'l Federation Wheat Producers (NFWP) is an annual quota, about 200,000 m.t. 1969. Markup about $56 m.t., 75% equiv. $75 ton c.i.f.
Rice	TARIFF + SURCHARGES (both specific): $42.85 per metric ton 1968, 16% equivalent when rice $271 m.t. c.i.f.	IMPORT TAX: 6.25%, on broken rice only.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Total NFWP import target is an annual quota, about 19,000 m.t. (milled basis) 1968. TARIFF: $34.87 m.t. if not from Portuguese Overseas Areas.
Barley	GLOBAL TONNAGE QUOTA FOR TOTAL FEEDSTUFFS: 1.3 million metric tons 1968. Import licenses required. TARIFF + SURCHARGES (both specific): Total $31.50 per m.t. 1968, 59% equiv. when barley $53.50 m.t. c.i.f.	STATE TRADING (TONNAGE QUOTAS MAY SPECIFY COUNTRY ORIGIN; VARIABLE SKIMMING LEVY ON ENTRY): 1968 quota 130,000 m.t. Preference to USSR by specification or other selective device. 1968 skimming Soviet barley $63 ton border was $13, 21%.	STATE TRADING (TONNAGE QUOTAS PLUS POSSIBLE PRICE MARKUPS ON RESALE): Total NFWP import target is an annual quota, negligible in 1968 except for malting barley. TARIFF: $34.78 m.t.
Corn	GLOBAL TONNAGE QUOTA FOR TOTAL FEEDSTUFFS: 1.3 million metric tons 1968. Import license required. TARIFF + SURCHARGES (both specific): Total $22 per m.t. 1968, 37% equiv. when corn $59 m.t. c.i.f.	STATE TRADING (TONNAGE QUOTAS NORMALLY GLOBAL; VARIABLE SKIMMING LEVY ON ENTRY): Grain Board 1968 skimming was about $27 per m.t. on Yugoslav corn at $50 per ton c.i.f. Austrian border, 53% tariff equivalent. 1968 quota 127,000 tons.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): NFWP import target 200,000 m.t. '69 Markup $25 m.t., about 38% equivalent when corn is $65 m.t. c.i.f. TARIFF: $20.87 m.t. PREFERENTIAL QUOTA Angola, Mozambique
Grain sorghums	GLOBAL TONNAGE QUOTA FOR TOTAL FEEDSTUFFS: 1.3 million metric tons 1968. Import license required. TARIFF + SURCHARGES (both specific): Total $18 per m.t. 1968, 28% equiv. when sorghums $65 m.t. c.i.f.	STATE TRADING (TONNAGE QUOTA NORMALLY GLOBAL; VARIABLE SKIMMING LEVY ON ENTRY): Skimming in 1968 about $7 per m.t. for sorghum at $65 per ton c.i.f. Austrian border, 11% equivalent. 1968 quota about 30,000 m.t.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Total NFWP import target is an annual quota, about 20,000 m.t. 1968. Markup $25 m.t., about 45% equivalent when sorghum $55 ton c.i.f.
Sources	U.S. Agricultural Attache Reports, Bern, Numbers AGR-16 (Oct. 4, 1966), SZ8030, SZ8037, SZ8060, SZ8063, and letters; U.S. Dept. Commerce Overseas Business Reports "Foreign Trade Regulations of Switzerland", June 1969.	U.S. Agricultural Attache Reports, Vienna, Numbers AT8054, AT8070, AT8081, AT8087, AT9003, AT9015, and letter.	U.S. Agricultural Attache Reports, Lisbon, Numbers PT8049, PT8085, PT8091, PT8117, and Salisbury, Rhodesia on Mozambique, Number MZ8089; Letter from U.S. Agricultural Attache, Lisbon.

Continued--

Table 7.--Trade barriers to grain imports in developed countries (continued)

Commodity	Country		
	Spain	Greece	South Africa
Wheat	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): 1968 quota negligible, in reality an IMPORT EMBARGO. TARIFF: 1%--COMPENSATORY IMPORT TAX: 8%--For small imports made, price markup added to above.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Quota about 11,000 m.t. 1968, but at least 103,000 m.t. 1969. Varies widely. 1968 markup about $30 m.t., 46% equiv. when wheat $65 m.t. c.i.f. Greek ports.	STATE TRADING WITH TONNAGE QUOTAS by Wheat Control Board. IMPORT EMBARGO 1968-69 TARIFF About $8 per m.t. 1964, 10% equivalent if wheat $80 m.t. c.i.f. South African ports.
Rice	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): IMPORT EMBARGO 1968 because of zero quota. TARIFF : COMP. IMPORT TAX Rough Free : 7% Brown Free : 8% Milled 4½% : 8%	GLOBAL TONNAGE QUOTA (milled, broken): About 3,900 m.t., 1968. PRIOR DEPOSIT - 119% PREFERENTIAL QUOTA to EC $75,468 (1969), about 444 m.t. if rice $170 c.i.f.	De facto QUOTA, about 79,000 m.t. in 1968, by IMPORT LICENSE REQUIREMENT. TARIFF: $77.17 m.t.
Barley	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Quotas and gov't. purchase suspended 1964 in favor of markup only, that is, VARIABLE LEVY: Example $15 in '68 + TARIFF 1% + IMPORT TAX 7%, total $20 m.t. 36% if c.i.f. $56.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Zero quota in 1968. Quota 1969 at least 18,000 m.t., markup about $21 m.t., 39% equivalent if barley $54 m.t. c.i.f. Greece.	STATE TRADING WITH TONNAGE QUOTAS by Wheat Control Board and S.A. Dept. of Agriculture. Imports are brewing barley only. 1968 quota about 8,600 m.t. PREFERENTIAL QUOTA TO AUSTRALIA.
Corn	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Quotas and gov't. purchase suspended 1964 in favor variable tariff plus 1% and 8% taxes, but quotas reimposed 1969 as TEMPORARY EMBARGO: Example 1968 total, $19 m.t. 35% if c.i.f. $55.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Quota 226,000 m.t. 1968. Markup about $32 per m.t. in 1968, 58% equivalent when corn $55 m.t. c.i.f. Greek ports.	STATE TRADING WITH TONNAGE QUOTAS, USUALLY AN IMPORT EMBARGO: Corn normally not imported, but if so under quota of Maize Control Board and S.A. Dept. of Agriculture. Preference to neighboring countries.
Grain sorghums	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Quotas and gov't. purchase suspended 1964 in favor variable tariff plus 1% and 8% taxes, but quotas reimposed 1969 as TEMPORARY EMBARGO: Example 1968 total, $17 m.t. 31% if c.i.f. $54.	STATE TRADING (TONNAGE QUOTAS PLUS PRICE MARKUPS ON RESALE): Zero quota in 1968.	STATE TRADING WITH TONNAGE QUOTAS, USUALLY AN IMPORT EMBARGO: Sorghums normally not imported but if so under quota of Maize Control Board and S.A. Dept. of Agriculture. Preference to neighboring countries.
Sources	Schertz, L. and K. Neeley, Barriers to International Grain Trade in Selected Foreign Countries, FAR-126, FAS, USDA; U.S. Agricultural Attache Reports, Madrid, AGR-71 (May 9, 1967), SP8067, SP8090, SP9007, SP9030, and letter.	U.S. Agricultural Attache Reports, Athens, Numbers AGR-57 (Feb. 24, 1968), GR8113, GR9010, GR9033, and letter; Foreign Trade Regulations, National Bank of Greece, Athens, 1965.	Schertz, L. and K. Neeley, Barriers to International Grain Trade in Selected Foreign Countries, FAR-126, FAS, USDA; U.S. Agricultural Attache Reports, Pretoria, AGR-61 (Jan. 25, 1967), AGR-5 (July 24, 1967), SA8053, SA9016, SA9052, and letter.

Continued--

Table 7.--Trade barriers to grain imports in developed countries (continued)

Commodity	Country		
	Canada	Australia	New Zealand
Wheat	IMPORT EMBARGO BY: IMPORT LICENSES Licenses controlled by Wheat Board and seldom granted for domestic use. TARIFF: 12¢ per bushel or $4.36 per metric ton, (m.f.n.) Free, British preference.	IMPORT EMBARGO BY: IMPORT LICENSE REQUIREMENT based on plant quarantine regulation. Licenses seldom granted. When granted, tariffs waived through by-law provisions.	STATE TRADING--FOREIGN EXCHANGE QUOTAS--IMPORT LICENSE REQUIREMENT--PREFERENTIAL QUOTA TO AUSTRALIA Total quota 1968 about 48,000 metric tons. Duty free.
Rice	TARIFF: - milled rice: 50¢ per 100 lbs., or $11 per metric ton, 7% if milled rice $160 per metric ton c.i.f. Canadian ports, (m.f.n.)	TARIFF: New Zealand: 5%; Com'wlth.': $23.21 m.t. plus 5%; General: $30.87 m.t. plus 5%	Duty free. Exempt from import license requirement beginning in 1968, but quotas and licenses were required previously.
Barley	IMPORT EMBARGO BY: IMPORT LICENSES Licenses controlled by Wheat Board and seldom granted for imported barley for domestic use. TARIFF: 7½¢ per bushel, or $3.44 per metric ton, (m.f.n.) Free, British preference.	IMPORT EMBARGO BY: IMPORT LICENSE REQUIREMENT based on plant quarantine regulation. Licenses seldom granted. When granted, tariffs waived through by-law provisions.	FOREIGN EXCHANGE QUOTAS Value quota allocated to barley usually zero. Normally, an IMPORT EMBARGO BY IMPORT LICENSE and decision of Dept. of Agriculture. If imports allowed, tariff would be waived.
Corn	TARIFF: 8¢ per bushel, or $3.15 m.t. (m.f.n.); Free, British preference. VARIABLE IMPORT SURTAX (1968 only) added to tariff as difference between $1.05 per bushel and c.i.f. price Canadian border if this price below $1.05.	IMPORT EMBARGO BY: IMPORT LICENSE REQUIREMENT based on plant quarantine regulation. Licenses seldom granted. When granted, tariffs waived through by-law provisions.	FOREIGN EXCHANGE QUOTA almost an embargo. De facto QUOTA BY IMPORT LICENSE: 1,900 m.t. 1968. TARIFF: $4.94 m.t. (m.f.n.) 8% equiv. if corn $60 ton c.i.f. For Australia and Commonwealth, $2.47 m.t.
Grain sorghums	TARIFF: 8¢ per bushel, or $3.15 per metric ton, 7% equivalent if sorghums $47 per metric ton c.i.f. Canadian border.	IMPORT EMBARGO BY: IMPORT LICENSE REQUIREMENT based on plant quarantine regulation. Licenses seldom granted. When granted, tariffs waived through by-law provisions.	FOREIGN EXCHANGE QUOTA almost an embargo. De facto QUOTA BY IMPORT LICENSE: 590 m.t. 1968-69 fiscal year.
Sources	Barriers to Int'l. Grain Trade, FAR-126, FAS, USDA; Report on Agric. Trade Negotiations of Kennedy Round, FAS-M-193; Journal of Commerce, Oct. 11, 31 and Nov. 8, 1968; Canadian and U.S. Tariffs, Ottawa, 1969; Letter from U.S. Agricultural Attache, Ottawa.	National Grain Policies, 1969, FAO; Letter from U.S. Agricultural Attache, Canberra; Australian Customs Tariff (revised to 1968); "Customs By-Laws", Dept. of Customs and Excise, Canberra, 1969.	Agricultural Policies in the Far East and Oceania, FAER-37, ERS, USDA; New Zealand Tariff Amendment, Chapter 10, 1969; U.S. Agricultural Attache Reports, Wellington, AGR-4 (Aug. 9, '66), NZ9025, and letter.

Table 8.--Import quotas: Total and per capita for wheat, rice, corn, and barley in developed countries, 1968 or 1969

Country	Wheat		Rice		Corn		Barley	
	Total	Per capita	Total	Per capita	Total	Per capita	Total	Per capita
	M. tons	Kg.	M. tons	Kg.	M. tons	Kg.	M. tons	Kg.
Australia	*	*	n.a.	n.a.	*	*	*	*
Austria	16,000	2.2	n.a.	n.a.	127,000	17.3	130,000	17.7
Canada	*	*	n.a.	n.a.	n.a.	n.a.	*	*
Denmark	*	*	n.a.	n.a.	n.a.	n.a.	15,700	3.2
Finland	19,100	4.1	n.a.	n.a.	13,900	3.0	*	*
Greece	103,000	11.7	3,900	0.4	226,000	25.7	18,000	2.0
Ireland	100,000	34.2	n.a.	n.a.	125,000	43.0	25,000	8.6
Japan	4,300,000	42.0	50,000	0.5	n.a.	n.a.	630,000	6.2
New Zealand	48,000	17.5	n.a.	n.a.	1,900	0.7	*	*
Norway	316,000	82.7	1,100	0.2	89,000	23.3	1/94,000	1/24.87
Portugal	200,000	20.9	19,000	2.0	200,000	20.9	*	*
South Africa	*	*	79,000	4.1	*	*	8,600	0.4
Spain	*	*	*	*	*	*	n.a.	n.a.
Switzerland	n.a.	n.a.	n.a.	n.a.	2/180,000	2/29.3	n.a.	n.a.
United States	21,800	0.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

n.a. Not applicable

* Negligible, de facto embargo.

1/ 1967.

2/ De facto quota. Is a part of total feedstuffs quota of 1.3 million metric tons, which is not allocated by commodity.

Source: Table 7 and (12).

Table 9.--Tariff rates: Approximate ad valorem equivalents for specific duties on grain imports, 1968 or 1969 1/

Country and type of rate	Wheat	Rice, milled	Barley	Corn	Grain sorghums
			Percent		
United States (GATT)	15	31	6	8	20
EC	89	65	102	57	65
Japan	2/ 24	2/ 53	2/ 18	Free of duty 3/	Free of duty 4/
United Kingdom (Full)	5/ 3	8	7	2	Ad valorem
Ireland	6/ 11	Free of duty	Free of duty	5	Free of duty
Denmark	29	Ad valorem	54	17	29
Norway	2/ 39	Free of duty	2/ 47	2/ 67	2/ 51
Sweden	86	Free of duty	123	123	121
Finland	Free of duty	61	104	55	42
Switzerland	21	16	59	37	28
Austria	2/ 16	Ad valorem	2/ 21	2/ 53	2/ 11
Portugal	2/ 75	2/ 21	2/ 63	2/ 38	2/ 45
Spain	Embargo 7/	Embargo 7/	36	35	31
Greece	2/ 46	Free of duty	2/ 39	2/ 58	Embargo 7/
South Africa	Embargo 7/	35	Free of duty	Embargo 7/	Embargo 7/
Canada (M.F.N.)	8/ 8	8/ 7	8/ 6	8/ 6	8/ 7
Australia (General)	Free of duty	14 & 10 ad val.	Free of duty	Free of duty	Free of duty
New Zealand	Free of duty	Free of duty	Free of duty	8	Free of duty

1/ This table is not a complete listing of trade barriers for grains. It concerns only specific duties, that is, those stated in a currency unit for a certain commodity weight. Estimated rates were calculated as shown in Table 7.

2/ State trading price markup on resale by the government or semi-government agency.

3/ Except that corn for industrial purposes in excess of the tariff quota amount may be subject to a specific duty of about 40 percent equivalent.

4/ Except that sorghums for industrial purposes in excess of the tariff quota amount may be subject to a 5 percent tariff.

5/ Applied, but not too often.

6/ Wheat for food only; assumed c.i.f. $65.

7/ The term "embargo" is listed where there is state trading, with price markups on resale, but where the complete lack of recent imports by the state trading agency gives no clue as to what the size of a price markup would be.

8/ Assumed c.i.f. prices per metric ton at country border or port, where not shown on Table 7: Canada: Wheat, $58; Rice, $160; Barley, $54; Corn, $50; Grain sorghums, $47; Finland: Rice, $175; Barley, $57; Grain sorghums, $56; Portugal: Rice, $170; Barley, $55; South Africa: Rice, $220; Australia: Rice, $220.

Source: Table 7 and (12).

IV.—A WORLD TRADE MODEL[1 3]

This chapter is mainly a mathematical description of the world grain models used in this study. Readers not interested in this description may skip this chapter without loss of continuity.

The models generally proceed from a free international trade assumption and allow for interaction among countries and commodities. They then proceed to incorporate some common trade and domestic policies and institutional limitations which alter the free trade assumption. The validity of such models for trade and domestic policy has been demonstrated, but their usefulness for policy formulations has been limited.

The formal econometric models were designed to evaluate demand prospects and export earnings or import costs in less developed countries. They provide a basis (a) for determining the kind of statistical analysis needed to quantify the necessary relationships and (b) for making a set of internally and externally consistent projections under well-defined assumptions.

The econometric models for grain were designed to: (1) determine equilibrium quantities and prices of grain in some future period (1980) for the study regions at some level of exogenous (given) factors, such as population, income, changing tastes, or technology; (2) determine trade flows between regions consistent with the objective function of minimizing transfer costs; and (3) incorporate or take into account institutional constraints.

Two models were developed. Model I is essentially a set of simultaneous solution equations for the world grain economy. Model II incorporates this set of simultaneous equations into a larger linear programming model. This two-stage approach was taken to minimize the time and cost of testing the sensitivity of coefficients under different assumptions.

Model I includes a set of supply and demand equations for each of the three grains in each region and sets of price relationships to link commodities within and between regions. Prices were used to relate the behavior of each supply and demand equation within and between regions. Although prices have an important role in the model, other variables and relations are used to take institutional factors into account. The output of model I is equilibrium quantities and prices of the grains by regions for some level of exogenous variables such as population and income. Model I can be used for program evaluation when no information on trade flows is required.

In model II, an objective function based on transfer costs and a transportation matrix are added. In addition to determining equilibrium quantities and prices, model II assigns proper trade flows. Since the model no longer depends on a square matrix, it allows the incorporation of additional constraints. Thus, model II provides a more flexible tool to evaluate the effect of institutional and policy limitations. However, the cost per run is substantially higher for model II.

One of the advantages of an integrated mathematical model of this kind is that it permits the measurement of the *total* effect of a change in a single variable or parameter on any other variable in the system.

Variables in the Model

Although the final model used in the grain study contains three grains and 22 regions, the discussion below is generalized to cover M commodities and N regions to facilitate comparison with other models and application to similar problems. The detailed equations for the grain model are shown in appendix A, page 103.

The notation is necessarily complicated to permit identification of each activity, commodity, and region. Double letters are used for a single variable to avoid superscripts.

Variables to be determined:

QS_{ij} = Quantity of i commodity produced in j region.

QD_{ik} = Quantity of i commodity demanded in k region.

PS_{ij} = Producer price of i commodity in j region.

PD_{ik} = Consumer price of i commodity in k region.

PW_{ij} = PW_{ik} = Wholesale price of i commodity in each region.

PE_{ij} = Export price of i commodity in j region.

PI_{ik} = Import price of i commodity in k region.

PT_{ij} = Trade price; export price (PE_{ij}) for exporting regions; import price (PI_{ik}) for importing regions.

PB_i = Base price of i commodity arbitrarily chosen to translate export prices (PE_{ij}) or import prices (PI_{ik}) in j or k regions as a price differential (simplex multipliers or shadow prices, RP_{ij} or RP_{ik}) from the base price (PB_i).

RP_{ij} = Relative export price of i commodity in j region or a price differential from base price.

[13] In building this model, the authors took advantage of recent developments in the field of interregional analysis. Particularly helpful econometric formulations of the problem appear in Egbert and Heady (*34*), Takayama and Judge (*135* 136, *137*, 138), Bawden (*14*), and most recently Takayama (*134*) and Alm, Duloy and Gulbrandsen (*6*).

RP_{ik} = Relative import price of i commodity in k region.

QT_{ijk} = Flow of commodity i from region j to region k.

Variables assumed as given or known:

A_{ij} = A functional relationship of m number of factors affecting QS_{ij}. This relationship includes such factors as a variable to represent the level of fertilizer use or changing technology.

A_{ik} = A functional relationship of m numbers of factors affecting QD_{ik}. These relationships include special demand shifters such as population, income, and changing tastes.

MS_{ij} = Farm-wholesale price margin for i commodity in j region.

MD_{ik} = Margin between wholesale price and import price of i commodity in k region.

ME_{ij} = Margin between wholesale price and export price of i commodity in j region.

M_{ijk} = Margin between export price of i commodity in j region and import price in k region.

TC_{ijk} = Transfer unit cost of moving i commodity from j region to k region.

M_{ijk} = TC_{ijk} if margin equals transfer costs.

The variables defined as margins between different prices are margins only if there is a one-for-one correspondence in the movement of the two related prices. If the value of the coefficient in one of the price equations differs from one, as for example c_{ij} in equation (4) below, the variable (MS_{ij} in equation 4) becomes a constant in the equation and bears no relationship to the actual margin between the related prices.

Model I - Basic Simultaneous Equations Solution

Size

Commodities:	$i = 1, 2, 3, \ldots, M$
Producing regions:	$j = 1, 2, 3, \ldots, N$
Consuming regions:	$k = 1, 2, 3, \ldots, N$

Supply equations (M x N)

$$(1) \quad QS_{ij} - \sum_{i=1}^{m} a_{ij} PS_{ij} = A_{ij}$$

Demand equations (M x N)

$$(2) \quad QD_{ik} - \sum_{i=1}^{m} b_{ik} PD_{ik} = A_{ik}$$

Market clearing conditions (M)

$$(3) \quad \sum_{j=1}^{n} QS_{ij} - \sum_{k=1}^{n} QD_{ik} = 0$$

Farm - wholesale price relationship (M x N)

$$(4) \quad PS_{ij} - c_{ij} PW_{ij} = MS_{ij}$$

Consumer - wholesale price relationship (M x N)

$$(5) \quad PD_{ik} - d_{ik} PW_{ik} = MD_{ik}$$

Equivalence of wholesale prices (M x N)

$$(6) \quad PW_{ij} = PW_{ik} \text{ for } j = k$$

Wholesale - export price relationship (M x N)

$$(7) \quad PW_{ij} - e_{ij} PE_{ij} = ME_{ij}$$

Wholesale - import price relationship (M x N)

$$(7') \quad PW_{ik} - e_{ik} PI = MI_{ik}$$

Regional relationships (M [N-1])

$$(8) \quad PI_{ik} - PE_{ij} = M_{ijk}$$

The first six sets of equations are fairly basic supply, demand, and price equations. However, sets (7) and (7′) need further clarification. There are two possible relationships for each region, depending on whether the region is exporting or importing. Since by the mathematical necessity a region in a net trade model can be only an exporter or importer at any given period of time, for any region, either (7) or (7′) exists, but not both.

Up to this point, we have five (M x N) + M equations and six (M x N) unknown variables. In this counting, the equation set (6) is excluded since it merely recognizes that only one wholesale price exists whether it is identified as PW_{ij} or PW_{ik}. To obtain a unique simultaneous solution to the system, we need to add (M x N-M) or M(N - 1) more equations. This is obtained by adding (N - 1) relationships between the prices in the regions for each commodity. The M(N - 1) relations are shown in equation set (8). It should be noted that one equation less than the number of regions is required to complete the price linkage for each commodity.

The addition of equation (8) gives six (M x N) equations and six (M x N) variables to be solved, thus

permitting simultaneous solution of these equations to obtain the equilibrium quantities supplied (QS_{ij}), the quantities demanded (QD_{ik}), and the prices in each region subject to the interregional price constraint specified by equation (8). However, the interregional flows of trade will not be obtained from model I. We turn to model II to provide trade flows.

Model II - The Economic Framework for Linear Programming

The objective function to minimize transfer costs for each commodity is:

$$(9)\quad Z = \sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{n} TC_{ijk}\, QT_{ijk}$$

Subject to:
Supply and demand quantity constraints—

$$(1)\quad QS_{ij} - \sum_{i=1}^{m} a_{ij} PS_{ij} = A_{ij}$$

$$(2)\quad QD_{ik} - \sum_{i=1}^{m} b_{ik} PD_{ik} = A_{ik}$$

$$(3)\quad \sum_{j=1}^{n} QS_{ij} - \sum_{k=1}^{n} QD_{ik} = 0$$

Price relationships—

$$(4)\quad PS_{ij} - c_{ij} PW_{ij} = MS_{ij}$$

$$(5)\quad PD_{ik} - d_{ik} PW_{ik} = MD_{ik}$$

$$(7)\quad PW_{ij} - e_{ij} PE_{ij} = ME_{ij} \quad \text{(for exporting regions)}$$

$$(7')\quad PW_{ik} - e_{ik} PI_{ik} = MI_{ik} \quad \text{(for importing regions)}$$

$$(10)\quad PT_{ij} - PB_{i} = RP_{ij}$$

[PT_{ij} is either PE_{ij} or PI_{ik} and RP_{ij} are simplex multipliers (shadow prices) which appear as a dual solution to equations (11) or (12)].

Transportation constraints—

$$(11)\quad QS_{ij} - \sum_{k=1}^{n} QT_{ijk} = 0$$

$$(12)\quad QD_{ik} - \sum_{j=1}^{n} QT_{ijk} = 0$$

In model II, the inputs are identical to model I except that an objective function, representing a matrix of transfer costs, and transportation constraints are added. The regional relationships represented by equation set (8) in model I are replaced by a new set of regional relationships (equation 10). The set of transportation constraints (equations 11 and 12) represent the new feature. The output includes trade flows as well as equilibrium prices and quantities.

Some Specific Observations

The equations in the models are linear because the solution of the model involves matrix operations. However, nonlinear relationships could be used provided they can be transformed into linear relationships. Also, the data entering into market clearing identities must be in actual values.

Price equations are developed to permit evaluation of price movements at different marketing levels. The coefficient in the equations relating prices indicates the degree of sensitivity between movements in prices at two different levels. A value of zero means there is no relationship between prices at two levels; while a coefficient of one assumes a one-for-one relationship. For example, a value of 0.5 (trade sensitivity) in the wholesale-import price relationship assumes that for every dollar change in the import (world) price, the wholesale (internal) price will change by only half (50 cents).

The model is flexible since it can be extended to any number of regions and commodities so long as they are connected by price relationships. The only limitations are computer capacity and cost.

Significance of the Objective Function

The same computer program is used for both models. Since model I is essentially a set of simultaneous equations, the use of the linear programming solution technique requires the addition of an objective function. However, since it has a unique solution, the form of the objective function matters little. One can maximize revenue or minimize demand cost, using base year prices.

In model II, the objective function is the set of transfer costs related to shipments between the regions. In the classical transportation problem, the objective function is to provide a solution consistent with minimum transfer costs. However, given the institutional and policy constraints built into the model, the objective function minimizes transfer costs in a limited sense. Thus, the primary use of the objective function is to permit a solution of set of equations under conditions not feasible in the usual method of solving simultaneous equations. That is, the solution no longer depends on a square

matrix. Furthermore, the use of the objective function permits the use of inequality constraints, which add flexibility to the model.

The Role of Simplex Multipliers

In model II, the trade price (PT_{ij})—which can be either export price (PE_{ij}) or import price (PI_{ik})—is determined by base price (PB_i) and relative price (RP_{ij}), or $PT_{ij} - PB_i = RP_{ij}$. The PB_i variable is solved for directly in the model. The RP_{ij} variables, however, are simplex multipliers or the dual variables of the optimal solution of the transportation matrix. In economic interpretation of dual linear programming problems, they are generally called shadow prices. Since in transportation problems, activities represent trade flows and activity costs are transportation costs, shadow prices can be referred to more accurately as price differentials among shipping points. These price differentials added to the base price of a commodity result in trade prices in each country or region.

It should be noted that the computer system used for the model solves simultaneously for the primal and the dual. The duals of the transportation matrix are then treated as the right-hand side (RHS) of trade price functions to solve for trade prices.

Adaptations to a "Real" World

The world grain economy cannot be described simply through a set of standard supply and demand equations linked by prices. To be useful, the model must be capable of handling a number of institutional and policy constraints. These constraints can relate to such aspects as special trading arrangements between countries, quotas, export subsidies and policies, price support programs, and quality differentials.

A net trade model is limited in the sense that countries may both export and import a commodity having a broad spectrum of classes. For instance, the EC imports hard and durum wheat but exports soft wheat. One way to avoid this problem would be to classify hard and soft wheat as two separate commodities, but data are not available for such a classification on a world-wide basis. Another approach would be to put some lower bound on the flow of hard wheat from the United States and Canada to the EC. A third possibility would be to let the flow of hard wheat be some function of prices or other factors affecting the demand for hard wheat. All three possibilities are feasible.

Most primary products have multiple uses. This can be handled by either model I or II by providing separate demand functions for each use when data are available. For example, to obtain satisfactory results, some provision is made for feed use of wheat in the United States, Canada, and the EC. In this example, a separate demand function for feed wheat becomes a derived supply of feed competing with other feeds.

Because some commodities such as grains are storable, separate functions for the demand for storage may have to be specified. These may be fixed or functions of other variables in the model. Stocks, in turn, affect, directly or indirectly, other variables such as production and exports.

In some countries, complicated programs to control production cannot be represented by a standard supply equation. Production in a plan period may really be a residual. For example, the level of wheat production in the United States is determined more by the level of domestic and world demand than by supply of land, the price of labor, and the price of fertilizer. The loan rate, direct payments to participating farms, and export subsidies or payments thus take into account the demand factors specified. The model must be, and is, amenable to reflecting this behavior.

V.—DEMAND ANALYSIS

Use of the mathematical models for projections assumes that (1) the factors affecting demand for grain in a particular country can be identified and measured; and (2) when trade occurs between two nations, or among more than two, price can be used as the regulator of the trade flow necessary to balance world supply and demand. This chapter presents the statistical base for contructing mathematically the demand and price relationships used in the projections model discussed in chapter VII.

The identifiable factors affecting demand can be roughly divided into factors external and internal to agriculture. The external factors, which affect the level of consumption over time, are population, income, and tastes and preferences. The internal factors, which are jointly determined within the agricultural economy, are items such as prices, including those for competing and complementary commodities. Internal factors affect the distribution and relative importance of grain consumption in both the short and long run. External

factors evolve from development processes, while internal factors result from changes at a point in time. However, both types affect the composition of demand at all stages of economic development, and thus affect the total demand for grains. The effect of these demand factors has been measured and evaluated to the extent of available data. Whenever possible, results from other studies have been incorporated into the analysis.

The grain complex includes wheat, rice, corn, barley, oats, rye, and sorghums. Each is by no means a homogenous commodity. Most grains are composed of a number of classes and grades which differ in milling characteristics, use, nutritive value, and cost. Each class has its own proper market and demand function. However, demand analysis for each grain by class is not feasible because of the lack of reliable data, so this study considers each grain as a homogenous commodity.

Relative Importance of Grain Uses

Grain consumption can be roughly divided into three principal categories: direct human consumption; animal feed; and other, including industrial consumption, seed, and waste.

Human consumption includes grains eaten with virtually no processing and processed items such as flour and flour products, pearl barley, oatmeal, cornmeal, rice, and breakfast foods. Industrial consumption includes malt alcohol, starch, oil, and molasses. Demand for seed is dependent upon the area and the rate of seeding. In terms of total production, seed accounts for roughly 6 to 12 percent of wheat, rye, barley, oats, and sorghum production; 2 percent of corn; and 5 percent of rice. Waste has been estimated to constitute about 3 percent of production.

On a worldwide basis, direct human consumption constitutes about half the total demand for all grain; feed accounts for a third; and industrial uses, seed, and waste, for the remainder. However, the proportion of rice production used as feed and in industry is minimal. Only 5 percent of wheat production is used for feed, while four-fifths is used for human consumption. About a fourth of coarse grain production is used for direct human consumption, three-fifths for feed, and the remainder for industrial use, seed, and waste.

The relative importance of the uses of grain varies greatly from country to country. The amount and uses of grains can be explained to a large extent by per capita income. At low-income levels, almost all grain is consumed directly as food. Diets usually improve as per capita incomes increase, and this is generally associated with higher consumption levels of livestock products, which in turn translates into a larger proportion of grain fed to livestock.

At present, the developed countries, with about a fifth of the world's population, account for a little over half of world meat production and for about two-thirds of grain used for feed. The central plan countries, with 35 percent of world population, account for about one-quarter of both world meat production and grain used for feed. Finally, the LDC's, with 44 percent of world population and one-quarter of world meat production, feed only 9 percent of their grain supply.

If Communist Asia is separated from other central plan countries and included with the LDC's, the comparison becomes even more striking. Then the less developed countries, with 68 percent of world population, would account for 30 percent of world meat production and only 11 percent of the grain consumed as feed.

Economic Development and Demand for Grain

In the early stages of development, when economies are primarily noncommercial and agriculturally oriented, ecological factors have an important role in determining the pattern of food consumption. One or two main foods tend to become the staple items in the diet—such as rice in East Asia, wheat in West Asia, potatoes in Northern Europe, and corn or beans in Latin America.[14] But as the economy develops internally and becomes commercially oriented, diversification and improvement of the diet occur as a result of higher incomes and a more varied food supply.

In this developmental process, a shift from a cereal- or carbohydrate-based agriculture to a feed-livestock oriented agriculture generally evolves. A shift may also occur within the cereals group, the nature of such a shift depending on the initial pattern of cereal consumption. In countries where rice has been a staple, shifts in consumption might tend toward wheat. With continued economic development in all countries, one could visualize the eventual evolution of a more homogenous worldwide consumption pattern. However, because the initial food patterns have deep cultural roots, some regional differences should continue, at least within the time horizon of this study. For example, rice is expected to continue to be the basic food in Japan and East and Southeast Asia but only a minor food item in Western Europe, the United States and Canada.

One of the major problems of statistical measurement of evolutionary changes in demand is the lack of a suitable data series of sufficient length to reflect structural changes. An alternative would be intercountry or cross-sectional comparisons. This method is valid

[14] This sequence excludes nomadic people whose main source of food is of animal origin. But even here, the principle of availability also applies.

provided that: (1) a worldwide consumption function exists and is related to economic development, (2) the consumption levels and patterns in countries at any point in time represent stages in the development process, and (3) variation in consumption between countries not accounted for by the main sequence of events can be accounted for by other factors or ignored.

Consistent with the conditions above, Regier (116) dealt with the main sequence of events in the development of a world grain-livestock economy. His data base was a set of detailed supply-distribution tables construeted for three regional groups (developed, central plan, and less developed countries), 15 subgroups, and 69 countries. For most countries and regions, averages were centered on 1962.

By means of regression analyses, three basic world functions were generated: a consumption function for meat; a function for grain used as food; and a function for the amount (kilos) of grain used per kilo of meat produced at different stages of economic development. A world consumption function for grain fed to livestock was then derived by utilizing the functions for grain-meat ratios and the demand for meat under assumed levels of self-sufficiency in meat production in all countries.

Results of the analysis supported the hypothesis that there existed a world demand function for meat, since over 80 percent of the variation in meat consumption between countries was explained by the world demand function. The price elasticity of demand for meat was estimated to be -0.60, while the income elasticity of demand for meat was 0.65. Both elasticities were evaluated at the mean values of the variable and were consistent with values obtained from time series data in selected countries.

When direct human consumption of grain was related to per capita income (economic development), results indicated negative income demand elasticities in the developed (-0.27) and central plan (-0.11) areas. For the LDC's generally positive elasticities resulted, ranging from zero to nearly proportional to income. On the other hand, income demand elasticity for meat remained positive for all regions and areas: 0.60 for the developed areas; 0.63 for the central plan area of Europe; 0.85 for the LDC's; and 1.00 for Communist Asia. Coupled with these findings, Regier's study indicates that as meat consumption increases with income, both the share of grain allocated to livestock and the grain-meat ratio rise. The grain-meat ratios included 4.95 kgs. of grain to one kg. of meat in the developed area, 3.60 in the central plan area, and 1.30 in the LDC's. The world average ratio was 3.55 kgs. Surprisingly, the highest ratios were in Bulgaria, Yugoslavia, and Hungary (9.75, 8.64, and 7.49, respectively). These countries are relatively large grain producers with a relatively inefficient livestock sector. In Canada, the United States, and the EC, the ratios were 6.94, 5.55, and 4.11, respectively. The smallest ratio was 0.14 in West Africa.

The economic development sequence analyzed in Regier's study indicated the following: (1) at per capita income of $50-$100, direct human consumption of grains rises; meat consumption is under 10 kgs. per capita and rises relatively more than income; and very little grain is fed to livestock; (2) at per capita income levels of $100-$200, direct grain consumption levels off; per capita meat consumption is 10 to 20 kgs. and rises in proportion to income growth; and grain fed to livestock rises; (3) at per capita incomes of $200-$3,000, human grain consumption falls; the growth in meat consumption is 60 to 80 percent of that of income; grain allocated to livestock rises from 12 to 75 percent of domestic disappearance; and the grain-meat ratio increases from 2 to over 4. Hence, the key variables in the demand for grains, regardless of economic system and the level of development, seem to be the meat-grain ratio and per capita income (table 10). However, because the grain-meat ratio is low in the LDC's, the important variant in grain use there may be changes in the grain-meat ratio. On the other hand, income as it affects meat consumption is the chief variant in the use of grains in the developed countries.

Concentrating only on wheat, Hutchison, Naive, and Tsu (71) arrived at a similar conclusion regarding the relationship between the level of economic development and the demand for wheat: as per capita income rises from a relatively low level, direct human consumption of wheat will increase, but beyond a certain income level it will decline to a lower level and thereafter remain relatively stable. However, when wheat becomes price competitive with grains that have been traditionally used for livestock feed, per capita consumption of all wheat will continue to increase even if its use for food decreases or remains stable.

For most high-income countries, where direct per capita consumption is falling or has already reached its lower asymptote, income elasticities of demand ranged from -0.1 to -0.5. Japan, with a strong positive income effect, is a special case among the developed countries. It traditionally produced and consumed very little wheat; rice accounted for 86 percent of total grain consumption. But since World War II, Japan's pattern of grain consumption has changed considerably as a result of rapidly rising income and changes in consumers' tastes.

In most low-income countries, income elasticities are positive, ranging from 0.1 to 0.8. However, Argentina had a negative consumption response to income since it

is a major wheat-producing country and has traditionally had high levels of consumption.

Price Response and Substitution Effects

In the previous section, the emphasis was on shifts in grain demand generated by external factors. In particular, the focus was on economic development and the shift in demand to other grains, livestock products, and grain used for feed. In this section, the emphasis is on changes in consumption and demand due to changes in price.

Shifts resulting from a change in the relative price structure depend on whether the products involved are complementary or competing. Generally, the substitution effect due to a price change may be stronger than the substitution effect due to income changes. A moderate increase in a product's price does not lower consumers' income substantially, but it may affect consumption patterns in that a sizable shift from the relatively higher to the lower priced product may occur (86). For example, if wheat prices drop relative to rice and coarse grain prices, there could be substitution of wheat for rice in human consumption and wheat for coarse grains as feed.

While intercountry comparisons were useful in relating grain consumption to economic development, time series analyses shed light on the relationship of consumption to changes in the relative price structure. However, because the effect of price on the consumption mix of grains cannot be measured in isolation of other influences, the analyses also included variables for factors such as income. Also, use was made of a number of studies relating to long-term agricultural supply and demand projections for selected countries.[15] These studies support the following generalizations:

For the major grain-producing regions, both developed and less developed, the food demand for grain is inelastic. That is, consumers' response to price changes is relatively small. Thus, the demand for wheat as food is inelastic in North America, Western and Eastern Europe, Argentina, and Australia. But it is quite elastic in non wheat producing and low-income countries. The demand for rice is generally inelastic in rice-producing countries such as Japan and Southeast Asia, and in high-income countries such as the United States, Canada, and Western Europe. The food demand for coarse grains is generally inelastic, except in the poorer LDC's. On the other hand, in the developed countries, where coarse grains are used as feed, price elasticity is likely to be higher. This is a reflection of the price elasticity for livestock products. Likewise, price elasticity for the demand for feed wheat is considerably higher than that for food wheat. This is an important factor in those developed countries where a significant portion of wheat can be used in feed outlets.

[15] These studies were conducted under contract with USDA as part of a series to evaluate long-term supply and demand prospects for agricultural products throughout the world. They are marked with an asterisk in the references at the end of the report.

Japan

Studies have been conducted to explore the nature of grain demand in Japan, a major import market. One study (40, 41), an econometric investigation of the Japanese grain-livestock economy, consisted of two phases: (1) statistical analysis of historical relationships, and (2) development of a projection model. Regression results indicated a high interdependence between and within the supply of and demand for livestock products. Results indicated a growing demand for beef, pork, and chicken. In particular, a demand excess was reflected in rising prices of beef, indicating beef to be the preferred meat. The demand for beef and pork was quite responsive to price (greater than unity), implying that the demand for grain for feed should also be quite responsive to price. Japan's import policies with respect to meats continue to be restrictive, enabling the Japanese livestock sector to become competitive. Because of this, and since expansion possibilities of coarse grain production in Japan are limited, the price responsiveness is reflected in imports of corn and other feed grains. Rising domestic livestock prices relative to world prices would indicate that grain imports were also curtailed but not to the same extent as imports of meats. Thus, the effective response of imports to changes in world prices is smaller than if the above restrictive import practices were not in effect.

Several regressions were run in the present study to measure shifts in grain consumption in the Japanese market arising from changes in the relative price structure. The price of rice may not have an important effect on consumption in other developed regions, but in rice-consuming countries it would be expected to be an important determinant because of its impact on consumers' buying power (income effect). Thus, relative prices, as well as underlying trends, would be expected to affect jointly the consumption of rice and wheat in Japan. To test the hypothesis, several regressions were run using data for 1957-67. The results are summarized below:

$$(13)\quad X_1 = 131.686 - \underset{(6.30)}{\underset{(-.52)}{134.109}} \log X_4 + \underset{(1.74)}{\underset{(.52)}{133.649}} \log X_5$$

Table 10.--Critical ranges in the development sequence of a world grain-livestock economy

Human consumption per capita		Grain allocation to livestock	Grain-meat ratio	Income range per capita
Grain	Meat			
Rising fast, nearly prop. to income	None	None	None	Under $60
Rising	Under 10 kg. rising more than prop. to income	Under 1 percent of domestic disappearance	Very low--below 1.0	$50-$100
About level	10 to 20 kg. rising prop. to income	1 to 12 percent of domestic disappearance	Low--but doubles to about 2.0	$100-$200
Falling	Moderate to high--rising at 60 to 80 percent of income rise	Rising from 12 to 75 percent of domestic disappearance--about prop. to rise in meat cons. pc.	Moderate to high--doubles again to over 4.0	$200-$300
Critical value A	Minimum income elasticity of meat consumption--.55			($350)
Critical value B		Minimum income elasticity of feed grain share--.55		($500)

Reproduced from: Regier (116, table 55, p. 114).

$$- 9.795 \log X_7 + 5.572 \log X_8$$
$$(0.27) \qquad (0.94)$$
$$(.04)$$

$R^2 = .94$ D.W. = 1.62 S.E. = 1.59

(14) $$X_2 = -5.825 + 28.682 \log X_4 - 37.428 \log X_5$$
$$(4.87) \qquad (1.76)$$
$$(.46) \qquad (-.60)$$

$$+ 25.488 \log X_7 - 3.062 \log X_8$$
$$(2.54) \qquad (1.87)$$
$$(.41)$$

$R^2 = .98$ D.W. = 3.21 S.E. = 0.44

(15) $$X_1 = -50.779 + 0.0675X_6 - 0.488X_8 + 1.142X_9$$
$$(0.88) \quad (3.97) \quad (8.35)$$
$$(.06)$$

$R^2 = 0.99$ D.W. = 2.73 S.E. = 0.53

(16) $$X_2 = 50.779 - 0.0675X_6 + 0.488X_8 - 0.142X_9$$
$$(0.88) \quad (3.97) \quad (1.04)$$

$R^2 = 0.97$ D.W. = 2.73 S.E. = 0.53

(17) $$X_{1a} = 172.026 - 144.284 \log X_4 + 111.437 \log X_5$$
$$(7.37) \qquad (1.60)$$
$$(-.57) \qquad (.44)$$

$$+ 3.241 \log X_7$$
$$(0.17)$$
$$(.01)$$

$R^2 = .96$ D.W. = 1.80 S.E. = 1.56

(18) $$X_{2a} = -39.529 + 35.735 \log X_4 - 27.744 \log X_5$$
$$(5.87) \qquad (1.28)$$
$$(.52) \qquad (-.41)$$

$$+ 25.486 \log X_7$$
$$(4.31)$$
$$(.37)$$

$R^2 = .99$ D.W. = 3.08 S.E. = 0.48

Variables

X_1 = Per capita consumption of rice, kgs.

X_{1a} = Per capita consumption of rice adjusted for trend, kgs.

X_2 = Per capita consumption of wheat, kgs.

X_{2a} = Per capita consumption of wheat adjusted for trend, kgs.

X_3 = Wheat/rice per capita consumption ratio.

X_4 = Wholesale rice price index (1960=100).

X_5 = Wholesale price index of flour and products (1960=100).

X_6 = Ratio of flour and products prices to rice prices, pct.

X_7 = Per capita private consumption expenditure index deflated by consumer price index (1960=100).

X_8 = Time (1957=1).

X_9 = $X_1 + X_2$.

In the above equations, the first row of figures in parentheses under the regression coefficients represent the student "t" values. In this problem, a "t" value of over 2.4 indicates that the regression coefficient differs significantly from zero when tested at the 5-percent probability level. The second row of figures in parentheses refer to the computed elasticities at the mean values for the period. For example, the number -.52 under equation (13) is the elasticity of demand for rice with respect to the price of rice.

The direct and cross-price effects are of the correct sign, indicating that relative price levels do have an effect on the consumption pattern of wheat and rice. The size of the price coefficients also seems reasonable.

Rising incomes and price changes are not the only factors accounting for the shift from rice to wheat. Urbanization and industrialization may account for a large part of the shift by fostering a trend toward convenience foods. And wheat in bread form is more convenient than rice for lunches and snacks outside the home. It is assumed that the urbanization effect is reflected in the time variable.

Because of the difficulty in separating the effects of time and income in equations (13) and (14), consumption was run as a function of relative prices, the trend variable, and total combined consumption of rice and wheat. The coefficients associated with the trend variable in equations (15) and (16) were then used to adjust the consumption of wheat and rice.[16] The adjusted consumption data were used in the usual demand formulation (equations 17 and 18). The reasoning behind this approach is that the combined per capita consumption reflects the growth in cereals demand and the trend variable measures the shift between rice and wheat. Since there is less intercorrelation between the trend variable and the

[16] Only one of the regressions is needed to provide the necessary information for adjusting consumption. The trend coefficients are of the same magnitude but of different sign.

combined consumption figure than between trend and income variables, a better representation of trend is accomplished. As expected, the results show that a substantial underlying shift had been taking place between consumption of wheat and rice in addition to that due to relative prices and income. The regressions (equations 17 and 18) also confirmed expectations that the income effect for rice would be negligible and that for wheat would be significantly positive.

In summary, the results of these regression analyses indicate that relative prices did influence the consumption pattern of wheat and rice in Japan. A shift in price policy resulted in rice becoming more expensive than wheat during the latter part of the period under study. Because of this shift in policy, good cross price effects were obtained, reflecting strong substitution of wheat for rice.

The findings for Japan are significant because they may indicate forthcoming shifts in those rice-consuming, less developed countries that are beginning to start to climb up the economic ladder. In Taiwan and the Philippines, for instance, the substitution of wheat for rice is visible though not statistically measurable because the shifts have not yet become fully established. Likewise, attempts to measure statistically the substitution effect via prices using time series data for India and Pakistan have been disappointing. Some shift probably has taken place in all four countries with imported P.L. 480 wheat from the United States replacing rice in most years, especially the 2 drought years of 1965 and 1966. The absence of an urbanization variable in the analysis of Taiwan and the Philippines and India and Pakistan may have been responsible for its poor result. Price policies in these countries can be an important factor in the shift to wheat from rice.

Other Countries

The United States, Canada, and Western Europe are major users of grain for feed. For these countries, demand relationships from several published studies were incorporated into the projection model for grain. In a study of the United States, Ahalt and Egbert *(5)* related feed grain consumption to livestock production units, livestock prices, and feed grain prices. Their findings show that on the average, a 10-percent increase in livestock production units [17] will cause a 13-percent increase in grains fed. On the pricing side, a 10-percent increase in livestock prices would be expected to increase feed grain consumption by 3 percent, while a 10-percent reduction in feed grain prices would also increase consumption by 3 percent.

[17] Livestock production units are the sum of livestock production weighted by base period feeding rates.

Regier *(115)*, in a study of the EC, found the demand-price elasticity to be somewhat higher than the −0.3 for the United States. In a more recent study of several countries, Bjarnason *(18)* found similar results. He estimated the demand elasticities for the United States, Canada, and France to be in the order of -0.45, -0.59, and-0.50, respectively. For Argentina and South Africa, which use relatively little grain for feed, the demand-price elasticity was about -0.25, a much lower figure in contrast with the price elasticities of demand for feed grain in the United Kingdom and Japan, which were found to be about -1.0.

A projection model in a study of the United Kingdom *(79)* used demand-price elasticities for barley and oats in the neighborhood of -2.0. The reason for the higher direct-price elasticity is that the study used a comprehensive 39 by 39 food demand matrix which takes into account the cross effects of a wide assortment of products. The projections model in the present study used lower demand-price elasticites as it did not take into account the cross effects of all other foods.

Studies for price response in less developed countries are very limited. In most LDC's, the livestock industry has been a stagnating sector. The United Nations Food and Agriculture Organization *(55)* suggests that internal policies may be partly responsible for this condition. In countries where livestock farming offers substantial possibilities of expansion, there frequently exists an unsatisfactory price relationship between prices for feed grains, which are often raised to stimulate domestic food production, and prices for livestock products, which are controlled at low levels to keep down the urban cost of living. Thus, the policy to keep down the urban cost of living in a predominately cereal economy may result in unfavorable livestock-feed relationships for raising livestock.

Demand for Feed Wheat

Another example of price substitution is the recent increase in the use of wheat for feed in countries where stocks have increased sharply, particularly in Western Europe, Canada, and the United States. This is evidenced by the following regression for the United States based on data for 1956/57-1969/70:

(19) $X_1 = 6.414 - 21.89 \log X_2 + 11.16 \log X_3 - 2.078 X_4$

"t" values	(16.5)	(3.5)	(7.4)
Elasticities	(-4.6)	(2.4)	

$R^2 = 0.97$ D.W. = 1.89 S.E. = 0.335

Where:

X_1 = Wheat used as feed, million metric tons.

X_2 = Wheat price received by farmers (excluding payment), dollars per bushel.

X_3 = Corn price received by farmers (excluding payment), dollars per bushel.

X_4 = One for 1964/65 and 1967/68, zero all other years.

A dummy variable was used for 1964/65 and 1967/68 because of two very abnormal situations in which feed use was substantially less than what might have been expected. In 1964/65, there was a fundamental change in the wheat program that was followed by a substantial price drop. In 1967/68, use of wheat for feed was lower than expected because a record feed grain crop (although probably not fully reflected in market prices) resulted in heavy feed grain supplies that discouraged wheat feeding.

The regression results indicate that shifts in feed use are quite responsive to price changes as indicated by a direct price elasticity of −4.6 and a cross-price (corn) elasticity of 2.4. Use of a price ratio instead of prices as two separate variables in the regression brought equally good results. Graphic analysis for the EC also indicated that wheat was substituted for coarse grain in feed use, with the rate of substitution depending on the relative prices of wheat and feed grains. No regressions were run for the EC because of the limited years for which adequate price data were available. However, from the EC graphic analysis, it was calculated that a 1−percent change in the wheat/feed grain price ratio caused a 2.5−percent change in the opposite direction in the use of wheat for feed. This compared with a 4.3−percent change in the U.S. analysis. Because of this substitution effect, separate functions for feed use were formulated for the United States, Canada, and the EC in the projections model (see discussion on p. 61).

Demand Elasticities and Trends for Projections Model

This section presents the demand elasticities and basic trends (shifts) in demand that are assumed in the projection model discussed in chapter VII (see table 11). Since the equations in the projection model are linear, demand elasticities vary according to the level (value) of the variables. These elasticities correspond to the demand functions evaluated at 1964-66 averages of the variables. Any departure in the variable from these levels would alter the demand elasticity. For example, a higher price would increase the demand elasticity with respect to price. Likewise, a larger quantity would lower the demand-price elasticities even though the slope of the linear demand function remained the same.

The elasticities were based on the demand analyses discussed earlier in this chapter, with some modification. Several criteria were used in selecting the elasticities. First, substitution may occur directly among wheat, rice, and coarse grains as food products or indirectly through consumption of livestock products, or in both ways. Since the demand equations in the projection model were in terms of grain, different substitution rates (technical conversion coefficients) had to be reflected in the demand coefficients, depending on final use of grain. For example, in the LDC's,where most of the grain is used directly for food, the substitution is practically 1 for 1. On the other hand, if grain is consumed in the form of livestock products rather than directly, it may require as much as 5 tons of grain for feed to maintain the nutrient level of a ton of grain consumed directly. The cross-price demand elasticites in table 11 take into account the relative requirements of grain due to differing technical coefficients among grain uses. They also reflect the probability that shifts from consumption of grain directly as food may result in a more varied diet as well as increased consumption of livestock products. As a result, the gain in feed grain consumption may not be as large as it would have been had substitution been limited to the grains only.

The statistical analyses described above did not always clearly distinguish between growth in demand due to income and growth due to basic changes in tastes and preferences. Thus, the growth allowed for each in some regions was arbitrary, recognizing, however, that the two are interrelated.

In general, the income elasticities used tended to follow the patterns suggested earlier in the chapter; that is, for a given commodity in a specified single use, the elasticity tended to be higher in the less developed area than in high-income regions. For wheat, the income elasticities varied from a -0.3 in the developed countries to a 0.7 for West Africa, a less developed region. Income elasticities selected for coarse grains were relatively low in those LDC's where coarse grains are used mainly as a basic food staple. In contrast, the higher income elasticities for coarse grains used in the developed regions reflect the growth in demand for meat, which has a high positive response to income growth.

In the case of Japan, a higher income elasticity than that for the United Kingdom and the EC could have been used, but it was decided to follow more closely the pattern suggested by the statistical analysis on page 30 for Japan. Thus, the major thrust in demand growth for Japan is in the trend variable, indicating that the growth in coarse grain consumption is due as much to a change in basic food strategies as to growth in income.[18]

[18] See the discussion on eastern vs. western food patterns on p. 15.

Table 11.--World grain model: Demand elasticities and net trend assumed in projections to 1980

Region and product	Elasticity with respect to--1/				Net trend per year 2/ (demand shift)	
	Price			Income		
	Wheat	Rice	Coarse grains			
					1,000M.T.	Percent
Developed area:						
United States--						
Wheat	-0.2	0	0.1	-0.3	0	0
Rice	0	-0.2	0	0.2	0	0
Coarse grains	0.1	0	-0.4	0.45	0	0
Canada--						
Wheat	-0.2	0	0.15	-0.1	-120	-3.7
Rice	0	-0.3	0	0.2	0	0
Coarse grains	0.15	0	-0.5	0.3	-110	-0.9
EC--						
Wheat	-0.3	0	0.1	0.0	50	0.2
Rice	0	-0.3	0	0.2	0	0
Coarse grains	0.2	0	-0.5	0.55	0	0
United Kingdom--						
Wheat	-0.2	0	0.1	-0.2	18	0.2
Rice	0	-0.4	0	0.2	0	0
Coarse grains	0.05	0	-0.7	0.6	0	0
Other Western Europe--						
Wheat	-0.3	0	0.1	-0.3	18	0.2
Rice	0	-0.30	0	0.15	0	0
Coarse grains	0.2	0	-0.7	0.3	0	0
Japan--						
Wheat	-0.33	0.75	0	0.1	75	1.4
Rice	0.15	-0.30	0	-0.1	-14	-0.1
Coarse grains	0	0	-0.7	0.5	270	2.9
Australia and New Zealand--						
Wheat	-0.1	0	0	-0.2	-35	-1.4
Rice	0	-0.3	0	0.2	1	2.0
Coarse grains	0	0	-0.1	0.0	30	1.2
South Africa, Rep. of--						
Wheat	-0.3	0	0.1	0.0	5	0.4
Rice	0	-0.3	0	0.3	1	1.2
Coarse grains	0	0	-0.4	0.15	0	0

See footnotes at end of table

Continued--

Table 11.--World grain model: Demand elasticities and net trend assumed in projections to 1980--continued

Region and product	Elasticity with respect to--1/				Net trend per year 2/ (demand shift)	
	Price			Income		
	Wheat	Rice	Coarse grains			
					1,000M.T.	Percent
Central plan area:						
Eastern Europe--						
Wheat	-0.2	0	0.08	0.1	0	0
Rice	0	-0.3	0	0.1	0	0
Coarse grains	0.08	0	-0.30	0.1	0	0
USSR--						
Wheat	-0.2	0	0.2	0.0	70	0.1
Rice	0	-0.3	0	0.5	34	4.3
Coarse grains	0.2	0	-0.4	0.3	120	0.2
Communist Asia--						
Wheat	-0.1	0	0	0.0	20	0.1
Rice	0	-0.1	0	0.0	160	0.3
Coarse grains	0	0	-0.1	0.0	225	0.5
Less developed area:						
Central America & Mexico--						
Wheat	-0.4	0.15	0.2	0.4	25	0.8
Rice	0.3	-0.5	0.05	0.3	0	0
Coarse grains	0.15	0	-0.5	0.4	100	0.9
Argentina--						
Wheat	-0.3	0	0.05	-0.3	10	0.3
Rice	0.05	-0.3	0	0.3	3	2.2
Coarse grains	0.05	0	-0.4	0.0	100	2.2
East South America--						
Wheat	-0.2	0.1	0.1	0.2	0	0
Rice	0.2	-0.3	0.05	0.2	0	0
Coarse grains	0.1	0.1	-0.30	0.25	70	0.6
West South America--						
Wheat	-0.2	0.1	0.15	0.3	50	1.6
Rice	0.1	-0.3	0	0.3	0	0
Coarse grains	0.1	0	-0.4	0.45	0	0
East Africa--						
Wheat	-0.4	0.14	0.31	0.6	15	1.7
Rice	0.08	-0.3	0.20	0.5	0	0
Coarse grains	0.01	0.01	-0.2	0.4	0	0

See footnotes at end of table.

Continued--

Table 11.--World grain model: Demand elasticities and net trend assumed in projections to 1980--continued

Region and product	Elasticity with respect to--1/				Net trend per year 2/ (demand shift)	
	Price			Income		
	Wheat	Rice	Coarse grains			
					1,000M.T.	Percent
West Africa--						
Wheat	-0.5	0.32	0.34	0.7	30	3.6
Rice	0.06	-0.4	0.13	0.2	0	0
Coarse grains	0.01	0.01	-0.2	0.2	0	0
North Africa--						
Wheat	-0.2	0.02	0.05	0.3	110	1.3
Rice	0.40	-0.5	0.30	0.6	5	0.5
Coarse grains	0.05	0.01	-0.3	0.5	65	0.9
West Asia--						
Wheat	-0.2	0.01	0.04	0.2	0	0
Rice	0.23	-0.3	0.14	0.3	0	0
Coarse grains	0.10	0.01	-0.2	0.2	0	0
South Asia--						
Wheat	-0.5	0.16	0.02	0.4	240	0.8
Rice	0.09	-0.3	0.01	0.3	-50	-0.1
Coarse grains	0.05	0.05	-0.2	0.1	0	0
Southeast Asia--						
Wheat	-0.04	0.25	0	0.3	10	3.2
Rice	0	-0.1	0	0.0	-46	-0.3
Coarse grains	0	0.3	-0.5	0.5	115	3/
East Asia & Pacific Is.--						
Wheat	-0.5	0.37	0.22	0.4	50	1.8
Rice	0.02	-0.3	0.01	0.2	0	0
Coarse grains	0.04	0.26	-0.4	0.4	325	3.7

1/ Elasticities computed using 1964-66 average values.

2/ Net trend is a demand shifter taking into account the changes in tastes and preferences after allowing for changes in prices, income, and population.

3/ Computed percentage not relevant because of very small consumption in base period.

Similarly, the expected growth in wheat demand in Japan arising from a shift from rice to wheat is reflected in the trend variable.

For the LDC's that show potential for developing new tastes and preferences, strong positive trend factors were used for wheat and coarse grains. The trend factors were used instead of a higher income elasticity to avoid obscuring such development. For example, it is expected that the livestock industry (particularly poultry and hogs) may begin to grow in North Africa, East Asia, Southeast Asia, and Central America. However, this trend is partly dependent on the availability of imported grain. Also, growth in urbanization would tend to encourage a shift to wheat.

A strong positive trend for wheat and a relatively smaller negative value for rice was used for South Asia, indicating further substitution of wheat for rice. These trends reflect, in part, increased consumption of wheat as urbanization continues and the assumption that more progress will be made in improving yields in wheat than in rice.

For the EC and Western Europe, a growth trend is also used for wheat to reflect policies that would encourage the use of wheat for feed if countries in these regions continue to have surpluses (France and Spain, for example). Also, because a large portion of the EC's wheat is used as feed, the income elasticity for wheat in the EC is higher than in the United Kingdom and Other Western Europe, reflecting the strong demand for meat and livestock products.

The high growth trend in the USSR for rice reflects a low level of rice consumption in the mid-1960's because of cessation of rice imports from China.

Because of lack of information on income response, growth in demand for grain in Communist Asia is reflected in the trend variable.

In general, price response coefficients parallel those of income. A low price response was used when grain was consumed directly as food and a higher response when grain was used as feed. Within this pattern, the price responses for the LDC's were assumed to be higher than in developed countries because the budget effect is substantially greater in areas where cereal consumption comprises a very large percentage of total expenditures. On the other hand, in those LDC's where little grain enters commercial channels, the aggregate price elasticity tends to be lower.

Price elasticities (both direct and cross) also are higher when there is substitution between grains. The strong positive cross-price effects between wheat and coarse grains for the western developed regions indicate that there would be continued substitution of these grains in feed. There is also a strong substitution effect between wheat and rice (for food) in Japan, South Asia, and other regions where rice is a basic food. In Latin America, parts of Africa, and Asia, diet improvement may first lead to increased consumption of rice and wheat as food before the takeoff stage for livestock products is reached. This three-way substitution effect is reflected in the direct and cross elasticities of all three grains.

Prices and World Market Supplies

A key assumption in the world grain model is that the supply and demand conditions in one country are interrelated with those in other countries. This implies that price variations within countries are related and that price movements are good indicators of international trade flows. However, when prices in a country do not reflect world supply and demand conditions, it is assumed that policies of that country would explain the differences. For example, in some countries a variable levy system is used to offset the influence of lower priced outside supplies. A target price high enough to restrict imports is set and export subsidies are used to sell domestic supplies at lower world market prices.

Regressions relating grain export prices of Argentina, Australia, Canada, and the United States (adjusted for subsidies) to the import price at Rotterdam indicate that export and import prices for wheat and corn are highly correlated after allowing for transportation costs. Previous studies *(45, 47, 91)* conducted on grain prices also have observed and confirmed the closeness in movement in grain prices and have explained major departures from the "normal" expected pattern. For example, a small corn crop in Argentina would tend to raise the price of Argentine corn relative to the price of U.S. corn in Western Europe. But over time, the two prices for corn will tend to differ only by the amount allowable for quality and other real differences. Thus, it is not surprising that simple regressions relating export prices between Argentina, Australia, Canada, and the United States are also highly correlated. The high degree of association in the movement of these export prices implies that they all are generated by the same set of factors—those pertaining to the world supply and demand situation for grain.

To determine the extent to which the grain demand at the country and world level is related and to measure the influence of common factors on international trade prices, several regressions were formulated that express price as a function of world supplies and other factors.

These regressions may be looked upon as demand equations at the world level, even though one normally thinks of demand equations with prices as the independent variable and the quantity demanded as the

dependent variable. But Waugh (*148*) has found the former useful in practical demand analysis:

> I doubt if there is any such thing as 'the' elasticity of demand for wheat, for example. There would always be at least two kinds of demand elasticity; the elasticity of expected consumption with respect to price and the elasticity of expected price with respect to quantity sold. In general, these are not reciprocals of one another, because the two regression lines differ from one another. The curves of expected purchases as a function of prices and of expected prices as a function of quantities sold probably should not (both) be called demand curves—in order to avoid confusion. Back in the 1920's and 1930's, they were sometimes called 'supply-price' curves, and 'expected price-marketing' curves.

Since a single world price for grain does not exist, the export (or import) price of one of the major suppliers (or importers) was used as an indicator of the world price. This is permissible since country prices, as indicated above, were highly correlated. Because domestic supplies may have a special influence on the export price of a country, they also were included as an explanatory variable in the analysis. Time also was included as a variable to reflect basic trends and as an indicator of income growth.

Within this framework, the following regression based on Canadian export price as an indicator of world prices was run:

(20) $X_1 = 129.63 - 0.75\ X_2 - 0.73\ X_3 + 0.19\ X_4$

"t" values (0.1) (3.6) (0.7)

$R^2 = 0.62$ D.W. = 1.82 S.E. = 4.41

Where the figures in parentheses represent the student "t" values, the period analyzed was 1951/52-1966/67, and:

X_1 = Export price of wheat in U.S. dollars per ton (No. 1 Manitoba, basis in Store Ft. Wm./Pt. Arthur).

X_2 = Per capita Canadian wheat supply, production plus August 1 stocks, in 1,000 kilograms.

X_3 = Per capita world wheat production plus July 1 wheat stocks of the United States, Canada, Argentina, and Australia, minus per capita supply of wheat available in Canada (basis July 1 stock), in kilograms.

X_4 = Time with 1950/51 = 1.

D.W. = Durbin Watson statistic.

S.E. = Standard error of the estimate.

The analysis indicates that Canadian export prices are more responsive to world wheat supplies than to Canadian supplies. As would be expected, both domestic and world supplies have depressing effects (negative signs) on exported prices. A 10-percent increase in per capita world wheat supplies depresses the Canadian wheat export price by 9 percent. The price response to domestic supplies is not statistically significant. The small positive, but also not statistically significant, value for the time variable is consistent with expectations.

A similar analysis for Argentina also indicated that Argentina export prices for wheat are more responsive to changes in world supplies than to changes in domestic supplies. In this case, a 10-percent increase in per capita world supplies would result in an 11-percent decrease in the export price in Argentina. The regression for Argentina is:

(21) $X_1 = 147.20 - 0.007\ X_2 - 0.79\ X_3 - 0.94\ X_4$

"t" values (.03) (2.3) (1.68)

$R_2 = 0.60$ D.W. = 1.13 S.E. = 9.1

Where the period analyzed was 1951/52-1966/67, and :

X_1 = Export price of Argentine wheat in U.S. dollars per ton (No. 1 Semihard and Hard, f.o.b. Buenos Aires).

X_2 = Argentine per capita wheat supply (production plus beginning stocks) December 1 crop year basis, in kilograms.

X_3 = Per capita world wheat production plus July 1 stocks of four major exporters minus supplies in Argentina, in kilograms.

X_4 = Time, 1950/51 = 1.

One could infer from the relationships for Canada and Argentina that the world elasticity of demand for wheat was near unity since the price flexibilities indicate that the relative changes in price and supply levels are about the same. However, these relationships indicate that the inelasticity of demand confirmed by other analyses is being muted by the price, supply, and export policies of the major exporters. On the other hand, the Canadian and Argentine analyses show that the major exporters cannot completely isolate the effect that a

substantial production change would have on the world price level.

Hutchison, Naive, and Tsu (*71*) also related the domestic farm price of wheat to world supplies and similar factors for Canada and Argentina. As expected, world wheat supplies had considerably less impact on domestic prices of wheat than on export prices.

The import price for corn in the United Kingdom was used as an indicator of world coarse grain supply and demand conditions in the following regression analysis:[19]

(22) $X_1 = 13.875 - 0.00368\,X_2 - 0.0246\,X_3 + 0.0766\,X_4$

"t" values	(3.7)	(2.8)	(2.5)
Price flexibilities	(0.6)	(0.8)	

$R^2 = 0.63$ D.W. = 1.8 S.E. = 0.29

Where the period covered was 1955/56-1968/69, and:

X_1 = c.i.f. price for U.S. No. 3 yellow corn, United Kingdom, nearest forward shipment, cents per kilogram.

X_2 = Per capita supply of coarse grains in United States (production plus beginning stocks), in kilograms.

X_3 = Per capita supply in developed world excluding the United States plus Argentina and Southeast Asia, in kilograms.

X_4 = Time, 1955/56 = 1.

As expected, coarse grain supplies in the United States are a major factor influencing the level of world prices since U.S. trade comprises over half of world coarse grain trade. Supplies in other major exporting and importing countries also are important in the determination of world prices. The statistically significant positive coefficient associated with the time variable represents the influence due to income growth and other underlying factors associated with time. During the period of analysis, incomes were growing and the time variable can be used as an indicator of income growth.

As in the case of wheat, coarse grain price flexibilities of less than one suggest that demand is relatively elastic. But here again, trade policies and institutional arrangements tend to mute the full effect of year-to-year changes in world supplies on prices.[20] However, the results do indicate that supplies affect price levels.

Demand for Stocks

Grain stocks in many of the major producing countries tend to increase when production is large and prices decline. In most of these countries, government programs support this movement in an effort to maintain relatively stable prices. For example, U.S. price supports permit farmers to put their grain under Government loan (into storage) if prices in the open market fall below the loan level. Canada's wheat program allows farmers to deliver only specified quantities (quotas). Thus, when export prices are low and production is high, relatively tight delivery quotas result in an increase in wheat stocks held by Canadian farmers. To measure these relationships, the following regression for Canada was run:

(23) $X_1 = 23.356 + 0.742\,X_2 - 0.515\,X_3$

"t" values	(4.62)	(2.20)

$R^2 = 0.67$ D.W. = 2.25 S.E. = 1.68

Where the period covered was 1951/52-1966/67 and:

X_1 = Changes in wheat stocks, July-June, in million tons.

X_2 = Canadian wheat production, in million tons.

X_3 = Export price of No. 1 Manitoba Northern at Ft. William/Pt. Arthur, in U.S. dollars per ton.

The above regression gives statistical support to the expectations that stocks are built up at times of large production and low prices. Hutchison (*71, p. 18*) also ran similar regressions for Argentina and Australia, with less conclusive results. The coefficient associated with production in both countries was statistically significant, of correct sign, and less than half the size of the Canadian coefficient. The production response coefficients are roughly proportional to production in each country. However, in both Argentina and Australia, the regression results indicated a positive price influence when a negative influence was expected. Apparently the rapid increases in production in the 1960's and the price control by the Australian Government are enough to cause the unexpected sign for price.

[19] The price at Rotterdam or the U.S. export price would have been a better indication, but longer historical series were not readily available.

[20] In addition, the use of a reciprocal of a regression coefficient from least squares analysis of demand elasticity has an increasing upward bias as the value of R^2 decreases.

VI.—SUPPLY RESPONSE

The major factors influencing the supply of grain can be broadly classified into product and input prices; technology of production; and agricultural infrastructure such as government programs, marketing and distribution systems, and credit facilities.

It is generally assumed that supply responses to changes in the infrastructure of agriculture are positive and strong, but precise measurements of these responses are lacking because of inadequate data. Investments to induce changes and benefits derived from changes in the infrastructure are spread over a number of years. Also, benefits accrue jointly to all crops, which makes it very difficult to measure the response of any particular one. In this study, supply responses of any particular grain to changes in infrastructure were dealt with as trends developed from production time series after price and other identifiable influences had been taken into account.

The discussion on supply response in this chapter is centered on the effects of price and technological change.

Price Effect on Production and Market Supply

It is generally agreed that in a developed economy, an increase in the market price of a commodity stimulates production, while a decrease in its price has the opposite effect. There exists, however, disagreement concerning farmers' response in a less developed economy. Three major hypotheses have been advanced: (1) that farmers in less developed economies respond to price changes in the same way as do farmers in developed economies; (2) that they respond inversely to price changes; and (3) that institutional constraints imposed on the farmer make price responsiveness insignificant. The situation in Thailand provides strong support for the first hypothesis and reiterates earlier findings by Schultz (*124*, *125*), Dantwala (*30*), Falcon (*38*), and others. Evidence in support of the second hypothesis can be found in the works of Newmark (*107*), Enke (*36*), Olson (*109*), and Krishnan (*81*) and in support of the third hypothesis, in Boeke (*21*). The three hypotheses are not necessarily contradictory if a distinction is made between total and marketed production and shortrun and longrun price response. Since the time reference of this study is long range and market production is increasing rapidly, normal price responsiveness is assumed for less developed as well as developed areas.

An important consideration in evaluating and selecting the "correct" supply-response coefficient is the period of run or time of adjustment.[21] In this study, we assume that sufficient time occurs between the base period (1964-66) and 1980 to permit the grain economy to fully adjust to the new situation postulated under alternative projection sets. The study does not attempt to trace year-to-year changes but, rather, presents final equilibrium values. Price coefficients in the supply equations reflect the required adjustment.

Another price response consideration is whether to use production directly as a dependent variable or, alternatively, to use area and yield separately before combining their results. Production was used directly in this study; however, both yield and area adjustments were considered in selecting the direct- and cross-price elasticities. For example, as a result of an increase in the price of wheat, both the area and yield of wheat would be expected to increase. The increase in area was translated into an increase in wheat production by an assumed change in yield per hectare. The additional wheat acreage could come from area used for coarse grains or other crops or from unused land. If from coarse grain area, the loss in that area was translated into a decrease in coarse grain production by using an assumed yield change through a cross-price coefficient for coarse grain. Thus, consistency was maintained for the coefficients in both the wheat and coarse grain production functions.

To facilitate comparisons, the price coefficients used in the study are shown in table 12 as direct- and cross-price elasticities. These elasticities are discussed below for the developed, central plan, and less developed areas.

Developed and Central Plan Areas

In 1964-66, the developed area produced about 58 percent of world grain production, or an average of 904 million tons a year. Price-supply responses in the developed area vary widely because of such factors as a nation's international trade position, its economic system, its agricultural production policies, and its production alternatives.

---

[21] Analyses of supply evaluated for this study usually presented results in terms of shortrun and longrun elasticities in a Nerlovian context (*106*); that is in some form of a distributed lag. Neither one of these elasticities is satisfactory for use in this study, since the shortrun response normally refers to an adjustment that takes place within a year while the longrun response (usually higher) refers to the full adjustment following a price change under ceteris paribus conditions. However, use of lagged production in a regression equation as an indicator of the adjustments in production due to previous price changes may lead to a specifications problem (see Griliches, *61*). Lagged production may also reflect yield effect which may be the result of technological change rather than price change. One only needs to examine results from regressions using lagged production (or area) and a trend variable separately or in combination to surmise the dilemma facing the analyst in choosing the "correct" specification of the regression.

Supply is generally more responsive to price changes in exporting countries than in importing countries, except in the United States, where acreage allotments and payments to participating farmers are overriding influences.[22] However, in the past decade, U.S. production of wheat, rice, and coarse grains has been responsive to changes in the supply-demand level of stocks, anticipated domestic utilization, and world import demand. For example, wheat and rice allotments were raised in 1967 following a tight world situation but were subsequently reduced in 1969 when world stocks began accumulating again.

Adjustments in U.S. grain production levels also influence the world supply-demand situation as the United States makes a major contribution to world grain trade (see tables 2, 4, and 6). Thus, major changes in U.S. grain production are determined by stock levels which, in turn, are influenced by world supply-demand conditions. For this reason, a stock variable is used in the production function for the United States to account for major changes in production (see pp. 61 and 105). Price-supply elasticities used in this study for wheat and coarse grains were estimated to be 0.2 for wheat and 0.3 for coarse grains, reflecting only minor changes in production due to price changes. Bjarnason *(18)*, using area seeded as the dependent variable, arrived at the short-range price elasticity for coarse grains of 0.69 and the long-range elasticity of 1.96.

Two other important developed exporters of wheat and coarse grains are Canada and Australia. In the past, under a quota marketing system, farmers in both countries based production plans on price expectations. More recently, stocks began to strongly influence production and, in Canada, quotas have been sharply reduced to curtail wheat production. For Canada, the assumed direct-price elasticity was 0.4 for both wheat and coarse grains. This compares favorably with a wheat area-price elasticity of 0.46 to 0.51 computed by Hutchison *(71)* and with Bjarnason's coarse grains area coefficient of 0.45 in the short run and 1.22 in the long run. Hutchison's computed wheat quantity elasticity for Canada is in the range of 1.39 to 1.69, but these coefficients have a strong upward bias because of rapidly improving yields. For Australia, the present study used the coefficient of 0.4 for wheat and 0.3 for coarse grains and rice. But Monash University's study of Australia *(31)* resulted in corresponding elasticites of 0.18 and 0.21. As Australia becomes a still larger exporter of grains, however, it should become more price sensitive. As in the case of the United States, a stock variable is also used in the production equation to adjust production (see pp. 62 and 105).

In the Soviet Union and Eastern Europe, central planning is a decisive influence and price responses are necessarily weak. The estimated coefficients were 0.2 for wheat and coarse grains and 0.3 for rice.

The principal developed grain importers are the EC, the United Kingdom, Other Western Europe, Japan, and Eastern Europe. Within the EC, however, France is an important exporter of wheat. For the EC, this study used direct-price elasticities of 0.3 for wheat and rice and 0.25 for coarse grains. Schmitz *(123)*, using traditional and Nerlovian models, calculated an area-price response of wheat in France of 0.05 to 0.20; and Oury *(114)* derived an area-price coefficient of 0.6 and a production-price coefficient of 0.9 to 1.1. Oury's quantity-price coefficients seem strongly biased upwards because of yield increases during 1946-61, the period of study. For coarse grains in France, Bjarnason obtained an area-price coefficient of 1.08 for the short run and 1.35 for the long run.

For other countries in the EC, Schmitz calculated an area-price coefficient for wheat of 0.1 for Italy and 0.2 for Germany. Bjarnason's coefficients for coarse grains ranged from 0.07 for Italy to 0.36 for the Netherlands. For the United Kingdom, the present study uses a direct-price elasticity of 0.4 for wheat and 0.3 for coarse grains.

In Japan, domestic grain production supplied only 62 percent of its total grain needs and only 16 percent of its wheat and coarse grain needs. As demand increases, these ratios will probably continue to drop. Government policy in Japan encourages a selective expansion of agricultural production, which includes production of livestock products. This necessitates the policy of a stable supply of feed grain imports under low tariffs. Hence, grain supply elasticities for Japan are significant, but differ considerably depending on the model used. This study used the elasticity of 0.4 for all grains. For wheat, this is substantiated by Filippello's study *(41)*, but Schmitz estimated it at 0.2. For coarse grains, however, Bjarnason calculated the area-price elasticity to be as low as 0.01 in the short run and 0.12 in the long run. This differs considerably from Filippello's long-range quantity-price elasticity of 3.96.

Less Developed Area and Communist Asia

In the base period (1964-66), the LDC's and Communist Asia were responsible for 42 percent of world grain production, of which Communist Asia's share was 15 percent. Within this grouping, Argentina and Southeast Asia are the only net exporters. However, Communist Asia exports considerable quantities of rice

[22] For this reason, it is not surprising that much supply response work in the grains area has used linear programming techiques to capture the effect of these constraints.

Table 12.--World grain model: Supply elasticities and net trend assumed in projections to 1980

Region and product	Price elasticities 1/			Net trend per year 2/	
	P_w	P_r	P_c	1,000 M.T.	Percent
Developed area:					
United States--					
Wheat	0.2	0	-0.15	328	0.9
Rice	0	0.2	0	48	1.7
Coarse grains	-0.05	0	0.3	4,950	2.9
Canada--					
Wheat	0.4	0	-0.07	-842	-7.1
Rice	--	--	--	--	--
Coarse grains	-0.15	0	0.4	325	2.0
EC--					
Wheat	0.3	0	-0.12	500	1.6
Rice	0	0.3	0	4	0.8
Coarse grains	-0.17	0	0.25	1,245	3.2
United Kingdom--					
Wheat	0.4	0	-0.22	40	1.1
Rice	--	--	--	--	--
Coarse grains	-0.06	0	0.3	310	2.7
Other Western Europe--					
Wheat	0.3	0	-0.19	120	1.1
Rice	0	0.3	0	8	1.7
Coarse grains	-0.10	0	0.25	560	2.6
Japan--					
Wheat	0.4	-0.27	-0.10	-26	-2.0
Rice	-0.02	0.4	-0.01	-16	-0.1
Coarse grains	-0.14	-0.32	0.4	-30	-2.5
Australia and New Zealand--					
Wheat	0.4	0	0	21	0.2
Rice	0	0.3	0	7	3.9
Coarse grains	0	0	0.3	210	4.7
South Africa, Rep. of--					
Wheat	0.25	0	-0.1	15	1.7
Rice	0	0.1	0	0.2	5.9
Coarse grains	-0.01	0	2.5	390	5.2

See footnotes at end of table

Continued--

Table 12.--World grain model: Supply elasticities and net trend assumed in projections to 1980--continued

Region and product	Price elasticities 1/			Net trend per year 2/	
	P_w	P_r	P_c		
				1,000 M.T.	Percent
Central plan area:					
Eastern Europe--					
Wheat	0.2	0	-0.11	655	2.6
Rice	0	0.3	0	.2	0.2
Coarse grains	-0.03	0	0.2	770	1.6
USSR--					
Wheat	0.2	0	-0.01	1,415	1.8
Rice	0	0.3	0	59	8.9
Coarse grains	-0.03	0	0.2	1,760	2.6
Communist Asia--					
Wheat	0.2	0	0	670	2.5
Rice	0	0.2	0	1,145	1.6
Coarse grains	0	0	0.2	1,305	2.3
Less developed area:					
Central America & Mexico--					
Wheat	0.3	-0.06	-0.2	87	3.6
Rice	-0.09	0.4	0	44	4.7
Coarse grains	-0.03	0	0.3	460	3.3
Argentina--					
Wheat	0.3	0	-0.13	66	0.8
Rice	0	0.4	0	8	5.3
Coarse grains	-0.18	00	0.3	300	2.7
East South America--					
Wheat	0.2	-0.08	-0.05	23	2.4
Rice	-0.01	0.4	-0.05	180	3.0
Coarse grains	-0.01	-0.02	0.3	560	3.7
West South America--					
Wheat	0.2	-0.3	0	19	1.1
Rice	-0.05	0.3	0	43	3.8
Coarse grains	-0.03	002	0.2	27	0.9
East Africa--					
Wheat	0.1	0	0	20	3.2
Rice	0	0.2	0	29	2.4
Coarse grains	0	0	0.1	527	3.4

See footnotes at end of table

Continued--

Table 12.--World grain model: Supply elasticities and net trend assumed in projections to 1980--continued

Region and product	Price elasticities 1/			Net trend per year 2/	
	P_w	P_r	P_c		
				1,000 M.T.	Percent
West Africa--					
Wheat	0.1	0	0	1	3.1
Rice	0	0.1	0	27	1.8
Coarse grains	0	0	0.1	190	1.5
North Africa--					
Wheat	0.3	0	-0.01	80	1.7
Rice	0	0.3	-0.06	71	4.1
Coarse grains	-0.02	-0.05	0.1	310	3.7
West Asia--					
Wheat	0.1	0	-0.03	360	2.4
Rice	0	0.25	0	41	3.5
Coarse grains	-0.01	0	0.10	180	1.9
South Asia--					
Wheat	0.2	-0.16	-0.08	1,750	7.8
Rice	-0.03	0.3	-0.04	1,680	7.2
Coarse grains	-0.02	-0.06	0.20	745	5.8
Southeast Asia--					
Wheat	0.1	0	0	2	2.3
Rice	0	0.3	-0.01	532	2.5
Coarse grains	0	-0.11	0.3	135	6.0
East Asia & Pacific Is.--					
Wheat	0.2	0	0	8	2.1
Rice	0	0.3	-0.01	500	2.4
Coarse grains	0	-0.03	0.2	370	4.2

1/ Elasticities computed using 1964-66 average values.
2/ Net trend is a supply shifter after allowing for changes in prices.

and occasionally small quantities of coarse grains, and Mexico exports relatively modest quantities of wheat and coarse grains.

In Argentina, over 60 percent of grain production is exported and, hence, short-range price expectations govern changes in production. However, the quantification of supply responses to price is complicated by the extreme variability of Argentina's weather. In times of low prices or poor weather, substantial grain areas may be used as pasture rather than harvested. The quantity-price elasticity used in this study was 0.3 for wheat and coarse grains and 0.4 for rice. This is very near the area-price elasticity of 0.26 computed by Bjarnason. However, Hutchison obtained a quantity-price elasticity for wheat of 0.9 and an area-price elasticity of 0.4.

In Southeast Asia, Thailand is the most important trading country. It is one of the world's largest exporters of rice and a rapidly developing coarse grains exporter. For these two types of grain, the supply-price elasticity for Southeast Asia was estimated at 0.3. The assumed price-supply elasticity for rice is strongly supported by Behrman (15) who, using area as the dependent variable, arrived at the short-range elasticity of 0.18 and the long-range elasticity of 0.31 for Thailand. Moreover, in areas of Thailand where alternative production opportunities exist, the elasticities are generally significantly higher. Corn production in Thailand is more localized than rice production. For the eight corn-producing areas in Thailand, Behrman calculated the area-price elasticity of corn to be 1.03 in the short run and 2.29 in the long run.

Price-supply responses in importing LDC's have been difficult to measure because of inadequate statistics. It is generally assumed that farmers in these countries respond to price in a manner similar to those in the developed area, but they more frequently face limitations inherent to subsistence farming.

Supply responses for the Central America and East South America groupings are assumed to be relatively high, because both Mexico (included in Central America in this study) and Brazil export substantial amounts of rice and coarse grains. Rice and coarse grain elasticites for Central America and East South America are 0.4 and 0.3, respectively. The elasticity of wheat in Central America is 0.3 and in East South America—a heavy importer—it is 0.2.

For North Africa, wheat and rice supply elasticities are 0.3. For South Asia (principally India and Pakistan) and for East Asia and the Pacific Islands (principally Indonesia, the Philippines, Malaysia, Taiwan, and Korea), the rice supply elasticity is 0.3 and wheat and coarse grain elasticities are 0.2. In other importing LDC's, the adopted elasticities are generally assumed to be 0.2 or less; in these regions, nonfood crops are generally more price-elastic than are food crops. The following evidence tends to support the elasticities used in this study for South Asia and East Asia and the Pacific Islands.

For wheat in the Punjab, Krishna *(81)* calculated the irrigated area response to price as 0.08 and the unirrigated area response as 0.22 for 1914/15-1943/44. Falcon *(38)* arrived at the irrigated area-price elasticity of 0.2 for wheat in West Pakistan.

For rice in undivided Punjab in 1914/15-1943/44, Krishna calculated the response of standard irrigated area to price as 0.31. For the Java-Madura region in Indonesia in 1950-62, Fletcher and Mubyarto *(42)* calculated an area-price elasticity ranging from 0 to 0.5. For the Philippines in the postwar period, Mangahas et al. (90) arrived at a set of area-price elasticities that ranged from 0 to 1.52 at up to 20-percent levels of significance. At lower levels of significance, these elasticities were not significant.

Finally for corn, Krishna gives an area-price elasticity of 0.23 for irrigated areas in undivided Punjab in 1914/15-1943/44. For the Philippines, Mangahas et al. calculated an area-price elasticity in Eastern Visayas ranging from 0.11 to 0.62 and for Mindanao, an elasticity of 0.08. But, as in the case of rice, these coefficients are not very significant. However, as a consequence of the applications of modern technology and as the country moves out of subsistence farming, the Philippines are expected to be more responsive to price changes.

Effect of Technological Change on Production

Technological change affects the supply of agricultural products by increasing production per unit of land and labor. In agriculture, it generally involves the introduction of machinery and mechanization; chemicals—fertilizers and pesticides; and improved crop varieties and livestock breeds. All three, however, are conditioned by and entail improvement in the quality of agricultural management.

Higher productivity stemming from the use of improved farm tools and mechanization has been sufficiently documented in the last two centuries and will not be given further attention in this study. Use of organic fertilizers to improve and maintain soil fertility is almost as old as agriculture itself. However, the development of chemical fertilizers and pesticides is a more recent improvement, dating to the second half of the 19th century. Increased use of these chemicals had been the principal factor in increasing crop yields in technologically advanced countries. For example, nearly half the yield increase in the United States since 1940 is

attributed to increased use of fertilizers, while the remaining increase is due to better cultural practices.

Crop yield responses to fertilizer applications have been well documented. Of particular interest, because of its scope, is the experimental work of FAO in the 1960's (*43*, *46*, *47*). The more successful results of FAO's work show that application to the soil of a suitable mixture of the three principal fertilizer nutrients—nitrogen (N), phosphate (P_2O_5), and potash (K_2O)—may increase grain yields 20 to over 150 percent, depending on type of grain, soil type, and soil moisture (table 13).

In the case of wheat, 40 kgs. of phosphate per hectare of unirrigated land in Syria increased yields 22 percent, and 60 kgs. each of nitrogen, phosphate, and potash per hectare of irrigated land increased yields 51 percent. In Lebanon, 60 kgs. each of nitrogen and phosphate per hectare of unirrigated land increased yields 128 percent; and 60 kgs. each of nitrogen and phosphate and 30 kgs. of potash per hectare of irrigated land increased yields 96 percent. The highest increase, 141 percent, was achieved in southern Morocco with the application of 20 kgs. of nitrogen and 40 kgs. of phosphate per hectare.

Rice yield increases in Senegal ranged from 27 percent in the Fleuve region, with 45 kgs. each of nitrogen, phosphorous, and potash per hectare, to 158 percent in the Sine Saloum region, with 90 kgs. of nitrogen only. Increases in other countries ranged from 49 percent in the Thrace region of Turkey, with 60 kgs. each of nitrogen and phosphate per hectare, to 123 percent in central El Salvador, with 90 kgs. of each fertilizer per hectare.

For corn, the increased yields ranged from 22 percent in the forest region of Nigeria to 105 percent for hybrid corn in northern Honduras. Most other increases were 50 to 85 percent (*43*).

Although optimum use of fertilizers is being approached in the developed countries of North America and Western Europe, there still is room for further expansion. Since the early 1950's fertilizer use has been expanding 5.5 percent annually in Western Europe and over 7.1 percent annually in North America. During the same period, fertilizer use in Eastern Europe has increased 9.7 percent annually, and in the USSR, 10.9 percent. The level of use in these two regions, however, is far below the optimum.

In the LDC's, use of fertilizers is still in the initial stage. With 70 percent of the world population, these countries accounted for only 7 percent of world fertilizer consumption in 1952/53-1956/57, and for 13 percent in 1967/68. During 1952-68, fertilizer use increased 13 percent annually (*53*). The potential for additional expansion of grain production with increased application of fertilizers and other chemicals would appear to be great.

Research on seed selection and hybridization to develop high-yielding and disease-resistant grain varieties has been carried out systematically since the end of the 19th centruy. An important breakthrough occurred in 1919 when scientists in the U.S. Department of Agriculture succeeded in identifying the genes that determine plant photoperiodism (*22*). This development has made it possible to select grain varieties adopted to a broad range of environmental conditions. Since 1950, remarkable results have been achieved with the high-yielding varieties of wheat, rice, and corn.

Major genetic and plant breeding research on wheat was carried out as part of a cooperative research program of the Rockefeller Foundation and the Mexican Government. The results were semidwarf wheat varieties that have a high grain-fertilizer response and that are resistant to lodging and adaptable to a wide latitudinal range. Success in developing high-yielding varieties of dwarf rice at the International Rice Research Institute in Los Banos, Philippines, was achieved in the mid-1960's. Use of high-yielding varieties of both grains has spread rapidly (*65*, *118*).

Use of the new wheat varieties spread to Turkey, Afghanistan, India, Pakistan, and elsewhere. India's wheat production increased from 12.3 million tons in 1965 to 20.0 million tons in 1970. In Pakistan, wheat production increased from 4.6 million tons in 1965 to 8.0 million tons in 1970. In India in 1967, when the new varieties were being introduced, the per hectare yield achieved with semidwarf varieties was 2,472 kgs., compared with 887 kgs. for all wheat. In Pakistan in the same year, the corresponding per hectare yields were 2,218 kgs. and 811 kgs. Tests on Sonora 63 in India showed that use of this new variety resulted in a 30- to 35-percent yield advantage over local varieties, with both being tested at optimum levels of fertilization. During 1965/66-1969/70 in the LDC's, the area sown to the new wheat varieties increased to nearly 10 million hectares, which accounts for about 24 percent of the total wheat area in these countries (*71*, *150*)

Use of the new dwarf rice varieties—IR-5, IR-8, and Dwarf Indica—spread in the Philippines, India, Pakistan, Indonesia, and other countries. By the 1968/69 crop season, about 5 million hectares were planted to the new rice varieties in Southeast Asia, or nearly 7 percent of the total area under rice in the region. Substantial increases are expected over the next few years. Tests on the new rice varieties showed their yield advantage over other varieties to be 30 percent or more. Tests conducted in India in 1966 resulted in yields of 3.2 tons per hectare for the Local Indica rice and 4.1 tons per hectare for the Dwarf Indica. At about the same time,

Table 13.--Results of fertilizer trials and demonstrations on corn, wheat, and rice, selected countries

Crop and country 1/	Fertilizer treatment $N-P_2O_5-K_2O$ (kg per hectare)	Yield (kg per hectare)		Yield increase		Net return to fertilizer		Output per kg. of nutrients
		Control	Fertilized	Kg per hectare	Percentage	Dollars per hectare	Per dollar of fertilizer	
Corn:								
El Salvador-central	90-90-0	2,420	4,146	1,726	71	93	3.1	9.6
Ghana								
Forest	22.4-0-22.4	1,419	1/ 2,287	868	61	47	4.6	19.3
Savanna	44.8-0-0	1,159	2,022	863	74	41	3.2	19.3
Honduras								
Hybrid-north	90-90-90	4,788	9,801	5,013	105	272	5.3	18.6
Local	45-45-45	1,674	3,110	1,436	86	64	3.0	10.6
Morocco-north								
Irrigated	40-40-0	1,436	2,395	959	67	31	2.9	12.0
Nonirrigated	0-40-0	648	1,053	405	62	13	2.8	10.1
Morocco-south								
Nonirrigated	20-40-0	723	1,139	416	58	9	1.7	6.9
Nigeria								
Forest	0-0-22.4	1,521	1,861	340	22	11	4.2	15.2
Savanna	0-0-22.4	1,262	1,559	297	24	9	3.7	13.3
Turkey								
Marmara	40-40-0	2,246	3,194	948	42	50	3.0	11.8
Black Sea	40-40-0	2,072	3,788	1,716	83	111	5.4	21.4
Wheat:								
Lebanon								
Irrigated	60-60-30	1,905	3,744	1,839	96	126	4.4	12.3
Nonirrigated	60-60-0	1,430	3,267	1,837	128	131	5.1	15.3
Morocco								
South	20-40-0	391	944	553	141	28	3.4	9.2
North	40-60-40	914	1,541	627	69	19	1.7	4.5
Syria								
Irrigated	60-60-60	1,860	2,802	942	51	11	1.3	5.2
Nonirrigated	0-40-0	968	1,181	213	22	2	1.2	5.3
Turkey-Central Anatolia								
Irrigated	60-60-0	1,530	3,010	1,480	97	86	3.3	12.3
Nonirrigated	30-30-0	1,401	2,104	703	50	40	3.1	11.7
Turkey-Thrace								
Irrigated	20-40-0	1,543	2,661	1,118	72	76	5.2	18.6
Nonirrigated	60-60-0	1,308	2,318	1,010	77	47	2.2	8.4

See footnotes at the end of table

Continued--

Table 13.--Results of fertilizer trials and demonstrations on corn, wheat, and rice, selected countries--continued

Crop and country 1/	Fertilizer treatment $N-P_2O_5-K_2O$ (kg per hectare)	Yield (kg per hectare)		Yield increase		Net return to fertilizer		Output per kg. of nutrients
		Control	Fertilized	Kg per hectare	Percentage	Dollars per hectare	Per dollar of fertilizer	
Rice:								
El Salvador-central	90-90-90	1,982	4,428	2,446	123	214	4.9	9.1
Ghana								
Forest	22.4-22.4-0	1,302	1,970	668	51	45	3.3	14.8
Savanna	26.9-26.9-0	1,797	3,218	1,421	79	113	5.8	26.4
Nigeria								
Forest	22.4-22.4-0	1,869	2,859	990	53	98	6.9	22.0
Savanna	22.4-22.4-22.4	1,289	2,051	762	59	69	4.4	11.3
Senegal								
Casamance	90-0-0	1,218	1,968	750	62	40	3.2	8.3
Fleuve	45-45-45	1,917	2,442	525	27	19	1.8	3.9
Sine Saloum	90-0-0	603	1,555	952	158	56	4.0	10.6
Turkey								
Central Anatolia	40-40-0	3,460	5,280	1,820	53	228	10.1	22.8
Thrace	60-60-0	3,545	5,288	1,743	49	204	6.4	14.5

Note: Results shown include only that fertilizer application showing the largest additional return per hectare of the crop. In some instances, a different fertilizer application produced a larger increase in yield, a higher net return per dollar invested in fertilizer, or a larger output per kg. of fertilizer applied.

1/ Data by area, variety, and irrigated or nonirrigated land included where available.

Source: (43). Reprinted in Fertilizer Manual. United Nations Industrial Development Organization. New York. 1967.

tests conducted in the Philippines showed the yield of Peta rice to be about 4.0 tons per hectare, compared with 7.1 tons for IR-5 and 6.8 tons for IR-8. Generally, the increases in yields range from 30 to 100 percent. Also, the new rice varieties have a shorter growing period than the traditional varieties and, hence, open more opportunities for double cropping.

For both crops, the new varieties are exceptionally productive when combined with high levels of fertilizer use and an adequate level of pesticide and water use. When no fertilizer is used, the new varieties seem to have no advantage over the traditional varieties. Also, because moisture requirements are high for the new grain varieties, they require controlled irrigation systems or exceptionally well distributed rainfall. Thus, investment in water control facilities is necessary for realizing the new varieties' potential *(69, 150)*.

The significance of these high-yielding, fertilizer-responsive grain varieties is enhanced considerably by the progress in mineral exploration, mining, and fertilizer manufacturing that lowers the cost of chemical fertilizers. The consequent declining real prices have greatly increased production and consumption since World War II, but further cost reductions will be necessary to make fertilizer use by farmers in the less developed countries economically feasible *(112, 12)*.

A significant and necessary attribute of yield-increasing innovations for the LDC's is that they can be readily available to users and are not dependent on large-scale production units. This facilitates their incorporation into the existing systems of small-scale LDC agriculture *(93, 108)*.

The acceptance and spread of the new high-yielding varieties in LDC's face, however, some serious obstacles. The most important is a shortage of good irrigation systems. Unless water can be carefully controlled, the advantage of the new varieties decreases rapidly. Many irrigation systems in the LDC's are not suitable because when the water flows by gravity from one field to the next, fertilizer and other chemicals are carried off in the water. Also, the lower fields may not dry out in time for the harvest, which poses the problem of wet grain at harvest time. In many LDC's, additional irrigation systems in broad valleys require large dams and long irrigation canals. Such systems cannot be built by local enterprise alone and will require large-scale government action to supply incentive, capital, and expertise. New forms of cooperative organizations may be necessary to coordinate the use of water. Where large underground water resources exist, irrigation by tube wells and pumps can be developed more cheaply and rapidly but this would still require large-scale land surveys.

Expanded use of multiple cropping would require skilled management to coordinate the planting and harvesting activities. Also, multiple cropping creates pest problems. For example, in Thailand, where year-round cropping has expanded, plants have been destroyed by insects and insect-borne diseases *(150)*.

Additional limitations on the spread of the new grain varieties are consumer acceptance and disposal of surpluses at competitive prices. New wheat and corn varieties do not seem to pose consumer acceptance problems. The rice varieties have met with consumer resistance, but expectations are high that further varietal improvements will correct the quality problem. Disposal of possible surpluses poses a more complex problem when competition on the international grain markets grows in intensity. High producer prices have provided incentives to the adoption of the new grain technology and they will have to be kept relatively high if the LDC's are to become increasingly self-sufficient in staple foods. Hence, an alternative to disincentive prices would be to keep producer prices relatively high and subsidize exports. But the gap between producer and export prices in most LDC's is wide and large outlays might be required *(150)*.

The relatively rapid spread of agricultural technology strongly supports the view that farmers in the LDC's respond to incentives if the inputs are available. Recent expansion of grain production by the LDC's through the use of technological improvements is sufficient evidence. But this potential could be severely limited by the cost of inputs, the lack of credit and extension services, and insufficiently developed marketing facilities, or, more generally, by unequal distribution of available capital and education throughout the world.

VII.—FRAMEWORK FOR PROJECTIONS TO 1980

Estimates of 1980 export earnings or import costs for wheat, rice, and coarse grains were made under three basic economic projection sets, each within a supply-demand framework. Projection set I assumes a continuation of present food and fiber policies in the less developed countries, allowing for moderate gains in productivity consistent with some improvements in available technology. Under sets II and III, respectively, higher and lower rates of agricultural productivity and economic growth in the LDC's would prevail than under set I.

Major emphasis is placed on projection sets I and II, since they are more consistent with current national goals of the LDC's and their development plans designed to accelerate economic growth. Set III is designed to illustrate how adverse economic conditions or shortfalls in national development objectives of the LDC's would affect their export earnings potential. The rates of economic growth and agricultural productivity in the developed and central plan areas remain the same under all three alternatives. Likewise, present food and fiber policies in these two areas are assumed to continue with little modification. However, to evaluate the effect of changing trade policies, several additional variants were included for major exporters and importers in the developed area.

The two key variables used to estimate 1980 export earnings (or import costs) are the quantities and prices at which grains would be shipped.[2 3] Quantities and prices were projected within a basic supply-demand framework that assumed interdependency within and among regions. Specifically, for each projection set, production, consumption, trade, and price levels were determined regionally for each commodity. A mathematical programming model was used to determine these projected values (see ch. IV).

One of the advantages of a mathematical model is that it permits measurement of the total effect of a change in a single variable or parameter on any other variable in the system. However, no formal mathematical model completely describes the real world. Such a description requires much more than a set of standard supply and demand equations that are linked by prices and that apply to commodities and regions. A useful formal model should be capable of handling mathematically any number of institutional and policy constraints, such as special trading arrangements, quotas, export subsidies and taxes, variable levies, food aid programs, storage capacity and policies, price-support programs, and quality differentials within commodities. The basic model in this study was designed to provide this flexibility.

General Assumptions

The projection sets in this study were based on certain assumptions. A preliminary set of production, consumption, and trade projections, based on 1964-66 prices, were made to tentatively determine potential surplus and deficit areas and the types of adjustment needed in the model to yield equilibrium conditions. Possible variations in population, income, and other factors affecting the growth in consumption and demand were held to a minimum.

As is usual, the projections imply the absence of major wars and natural disasters that would substantially change the underlying factors of future supply and demand prospects.

The reader, at this point, should be cautioned that these are projections and not forecasts of the future. Specifically, the probability that a particular set of projections would materialize depends on the likelihood of the assumptions and the relationships used in making the projections. Moreover, long-range projections or basic assumptions and relationships may be invalidated if they call attention to developing disequilibria that are followed by corrective action.

Population

The scientific and technological revolution which started in the developed countries over a century ago has only recently reached many less developed countries. Science and technology have had a dramatic effect on population in that they have accelerated growth rates by reducing death rates. From man's beginning (and archeologists now tell us this was more than a million years ago) to the start of this century, world population grew to 1 billion persons. Since then, it has increased to 3 billion. It is now estimated that by the year 2000, the population will have doubled, increasing to 6 billion persons.

The phenomenon of accelerated population growth has been particularly striking since World War II. It is most marked in the less developed countries, where there has not been a reduction in birth rates. The death rate in Ceylon is estimated to have dropped 40 percent in one year because of the use of DDT to combat disease-carrying insects. Malaria has been virtually eliminated in India, resulting in a sharp increase in average life expectancy. In the LDC's, as elsewhere, lives have been saved by rapid adoption of public health measures and advances in medical technology. But in the LDC's, improvements in living standards are being threatened because food production and distribution have not adequately kept pace with population and income growth.

Population is a key variant in the growth in demand for agricultural products. Thus, assumptions regarding population growth are of the utmost importance in agricultural demand projections. Original research on population growth, however, was not within the scope of this research. Consequently, the population growth rates used were based, with some modification, on the population projections of the Population Division of the United Nations. The Division's most recent world

[23] Prices are generally in terms of f.o.b. for exports and c.i.f. for imports.

population study was published in 1966 and the projections contained in that report have been widely used. Some adjustments to the UN projections were made based on more recent studies that have been conducted by FAO, the Organization for Economic Cooperation and Development (OECD), and the U.S. Department of Agriculture in its long-term supply and demand studies, cited on page 30.

For this study, a single population projection was selected for each country. The regional population projections that were used in the various commodity demand analyses are presented in table 14. It was not deemed necessary to develop both high and low population projections, reflecting different fertility rates, because any changes in these rates by family planning programs enacted now would have minimal effects by 1980.

Income Growth

Income is another key variant in growth in demand for agricultural products. With given levels of population, prices, and other factors, the rate of increase in income largely determines the pattern and level of per capita consumption. While population may be the most important demand factor in the LDC's, income is the most important contributor in countries like Japan, where population growth is less than 1 percent and income growth over 8 percent.

The projected growth rates in national income used in this study are presented in table 15. As with population, original research on the economic growth prospects of the countries of the world was not within the scope of this project. The projected growth rates selected were obtained through a careful review of studies in this area. Besides the trends in the historical time series data on national accounts, the main sources guiding the selection of final growth rates were reports by FAO (*44*, *48*, *50*, *51*, *54*) and OECD (110), and the USDA series of supply and demand studies on foreign countries.

The same income projections were used in all projection sets for the developed and central plan areas. However, for the LDC's, separate income projections were generated for projection sets I, II, and III that were consistent with the assumed growth in productivity. In these income projections, it is recognized that in the LDC's, agriculture accounts for a very large proportion of total economic activity, and growth in agricultural output has a decided impact on growth of the overall economy.

The agricultural sector provides a large and growing market for nonagriculturally produced goods in the LDC's. It also provides many raw materials for industrial production and export. An acceleration of the rate of growth in agricultural production not only provides more food and fiber to people, but (a) increases the demand for industrial products, and (b) increases the supply of agricultural raw materials with which to increase industrial production and exports. An attempt was made in this project to relate growth in income in the agricultural sector to increases in the rate of growth of agricultural output. Such accelerated economic growth increases incomes and the demand for food.

If growth rates in agricultural output were to double over a given period of time, the growth rates in total income and consumption would increase significantly. That is, per capita demand for food would change as per capita income rose. Thus, for a country that is a net importer of food, the absolute decline in imports resulting from increased domestic production would be less than the absolute increase in production.

A special study was made using data from 17 less developed countries to determine the relationship between growth in the agricultural sector and growth in the total sector. Regressions were run using the following model to determine the relationship between agricultural output and gross national product (GNP):

$$(24) \quad x_1 = a + b\,x_2 + c\,\frac{x_2}{x_1}$$

where x_1 equals the GNP of a given country and x_2 equals the value of agricultural output. The *b* regression coefficient from each country regression was plotted against an average percentage figure representing the country's agriculture as a percentage of its GNP (see fig. 1). The graph indicates a downward sloping function. For example, when agriculture is 50, 33-1/3, and 20 percent of GNP, the *b* coefficients are 2, 3, and 5, respectively. This suggests that after allowing for the shift in resources to the rest of the economy, the historical growth rates in the agricultural and nonagricultural sectors were indentical. In line with this conclusion, income growth in the LDC's was varied in the same proportion as growth in agricultural productivity.

Basic Equations

The complete set of equations used in the mathematical projection model for projection set I is shown in appendix A. For the other projection sets, only the modified and additional equations are shown. The theoretic and economic concepts fundamental to the equations used in the model are discussed in chapter IV. The basis for the parameters in the equations is discussed in chapters III, V, and VI. The model has been synthesized to be consistent with economic theory and

Table 14.--Total world population, 1965, and projections to 1980

Region	1965	1980	Projected annual rate of growth
	Thousands		Percent
Developed:			
United States	194,572	235,200	1.3
Canada	19,604	26,024	1.9
EC	181,594	198,385	.6
United Kingdom	54,595	60,690	.7
Other Western Europe	87,684	97,489	.7
Japan	97,960	111,563	.9
Australia and New Zealand	14,000	18,216	1.8
South Africa, Rep. of	17,867	26,000	2.7
Subtotal	667,876	773,567	1.0
Central plan:			
Eastern Europe	121,430	138,763	.9
USSR	230,600	277,325	1.3
Communist Asia	795,604	1,077,064	2.0
Subtotal	1,147,634	1,493,152	1.8
Less developed:			
Central America & Mexico	80,078	128,508	3.2
Argentina	22,354	28,381	1.6
East South America	96,052	146,544	2.9
West South America	47,640	72,260	2.8
East Africa	84,890	121,157	2.4
West Africa	132,564	194,463	2.6
North Africa	74,606	115,284	2.9
West Asia	87,877	131,372	2.7
South Asia	638,064	913,655	2.4
Southeast Asia	81,057	117,969	2.5
East Asia & Pacific Is	198,597	298,920	2.8
Subtotal	1,543,779	2,268,513	2.6
World total	3,359,289	4,542,608	2.0

Source: Summarized from a working paper (98) prepared for this study on World Population and Income by Countries 1950-65 and Projections to 1980.

Table 15.--National incomes, 1965, and projections to 1980 under projection sets I, II, and III 1/

Region	1965 2/	1980			Projected annual rate of growth					
					Total			Per capita		
		Proj. set I	Proj. set II	Proj. set III	Proj. set I	Proj. set II	Proj. set III	Proj. set I	Proj. set II	Proj. set III
	Million dollars				Percent					
Developed:										
United States	397,800	730,287	SAME AS PROJ. SET I		4.1	SAME AS PROJ. SET I		2.7	SAME AS PROJ. SET I	
Canada	27,142	50,551			4.2			2.3		
EC	146,351	274,955			4.3			3.7		
United Kingdom	53,917	85,202			3.1			2.4		
Other Western Europe	48,808	92,635			4.4			3.7		
Japan	34,887	110,667			8.0			7.2		
Australia & New Zealand	14,317	25,883			4.0			2.2		
South Africa, Rep. of	7,165	13,866			4.5			1.8		
Total	730,387	1,374,845			4.3			3.3		
Central plan:										
Eastern Europe	85,300	176,649			5.0			4.1		
USSR	219,700	499,852			5.7			4.4		
Communist Asia	85,600	158,669			4.2			2.2		
Total	390,600	835,170			5.2			3.4		
Less developed:										
Cent. Am. & Mexico	30,758	71,265	98,933	56,198	5.8	8.1	4.1	2.5	4.7	0.9
Argentina	16,050	26,116	31,510	22,907	3.3	4.6	2.4	1.7	2.9	0.8
East South America	31,852	66,009	87,881	54,142	5.0	7.0	3.6	2.1	4.0	0.7
West South America	15,368	31,034	40,652	25,376	4.8	6.7	3.4	1.9	3.8	0.6
East Africa	8,254	15,237	18,958	12,673	4.1	5.7	2.9	1.7	3.2	0.5
West Africa	14,445	26,899	34,132	22,505	4.2	5.9	3.0	1.6	3.2	0.4
North Africa	13,135	26,791	35,735	22,006	4.9	6.9	3.5	1.9	3.8	0.5
West Asia	26,650	57,853	77,761	46,629	5.3	7.4	3.8	2.5	4.6	1.1
South Asia	64,059	119,180	151,363	99,802	4.2	5.9	3.0	1.8	3.4	0.6
Southeast Asia	8,427	16,042	20,775	13,321	4.4	6.2	3.1	1.8	3.6	0.6
East Asia & Pac. Is	28,070	54,188	70,185	45,023	4.5	6.3	3.2	1.7	3.4	0.4
Total	257,068	510,614	667,855	420,582	4.7	6.6	3.4	2.1	3.9	0.7

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the LDC's. Set II assumes that agricultural productivity and economic growth in the LDC's would be higher than projected in set I. Set III assumes that agricultural productivity and economic growth in the LDC's would be lower than projected in set I.

2/ These values are in terms of constant 1958 dollars.

Source: (98).

"b COEFFICIENT" FROM REGRESSION ANALYSES RELATED TO VALUE OF AGRICULTURAL SECTOR AS A PERCENTAGE OF GNP

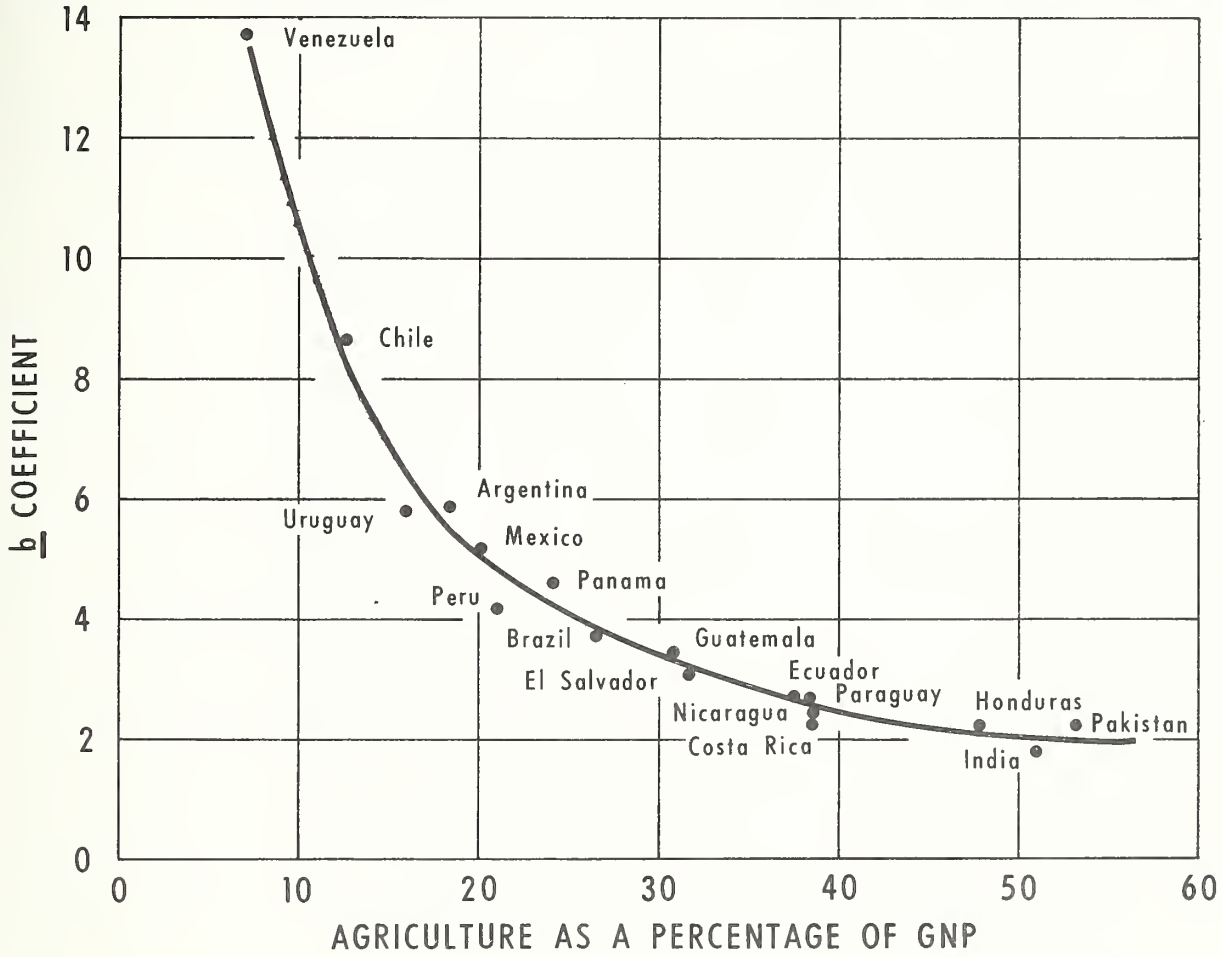

Figure 1

statistical findings to the extent possible. It is not a product of a direct statistical fit because of its size. Instead, to facilitate comparisons and permit evaluation of results and consequences under different assumptions, the model is an integrated framework of the behavioral pattern of the grain sector.

In the equations shown in appendix A, the variables on the left-hand side (LHS) of the equality sign are the quantities and prices which will be projected jointly. The variables on the right-hand side (RHS) of the equality sign are the variables which are estimated beforehand or assumed as given. These given variables are used to generate the projected prices and quantities. For example, income is a given variable in the demand equations.

Because the model was synthesized, the coefficients in the equations were developed from several sources to reflect the relationships among the variables. Data for 1964-66 were used to determine the value of the constants in the equations. In short, 1964-66 is the base for projecting to 1980.

The grain model divides the world into 22 regions.[24] It covers three commodities—wheat, milled rice, and coarse grains. The model assumes that the regions are linked through prices and commodity trade flows.

As indicated in chapter IV, the model contains supply and demand equations for each commodity in each region. It also contains price equations relating prices at different levels of the marketing sector in each region. The supply, demand, and price equations in each region are linked together through prices, transportation costs, and institutional and price constraints. In addition, for some regions special equations were

[24] As noted on p.103 this division includes some regions that are a single country.

developed, such as storage demand for major exporters and feed demand for wheat. The effects of policy are incorporated into the model by either varying the coefficients or adding constraint equations. These policies and their effects are discussed under specific assumptions in the following sections.

Supply Equations

The model includes 64 supply equations; there are no equations for rice in Canada and the United Kingdom (app. A, p. 105). The basic supply equation for each grain may have up to three price variables affecting production. It also includes a trend variable to allow for long run shifts in production, net of price changes but reflecting basic changes in technology. Additional variables in the supply equations are discussed under special country or regional situations.

As it is difficult to compare and evaluate the parameters in linear form, the basic response coefficients were converted into direct- and cross-price elasticities to facilitate comparisons among commodities and regions. These elasticities as well as the growth rates in production, net of price changes, are shown in table 12, page 43. The elasticity coefficients are evaluated at the mean values of the variables for 1964-66.

Even though area and yield were not estimated separately in the formal mathematical model, an attempt was made to assure consistent relationships among the direct- and cross-price effects that took into account yield and area changes. For example, for any price change (own or competitive grain price), it was assumed that one part of the change in production was comprised of a net addition or loss in production due to substitution of the area of one grain for the area of the competing grain. It was assumed that the other part of the production change came from an increase in yield or an increase in new area brought into total grain production.

The same basic price-response coefficients are used in all projection sets, except where noted. However, for the projection sets for the less developed area, there are different trend variables which correspond to the assumptions on agricultural productivity and economic growth.

Demand Equations

The basic demand equation formulated for the projection model relates consumption to own price, competing prices, income, population, and a trend variable. The demand equations used in the model are shown in appendix A, page 108. The measures of elasticity associated with the coefficients in the demand equations are discussed in chapter V (see table 11, p. 35). Growth rates in consumption (trends), net of price changes, are also discussed in chapter V.

The study assumed that the demand structure is basically the same for all projection alternatives. Hence, a single set of parameters is used to generate all price and quantity projections, except where noted. However, actual consumption levels in the LDC's are different under each alternative projection because of different income levels and prices resulting from assumed rates of agricultural productivity and, in some instances, because of the direct relationship between consumption and production.[25]

Except where noted, the demand for wheat includes all uses of wheat (in wheat equivalent) at the wholesale level. Lack of adequate information precludes relating wheat use to end uses, such as bread, pastry, and pastas.

Normally, in most regions the price of wheat is above the price of coarse grains, and wheat is not competitive with coarse grains. However, when the price of wheat falls relative to the price of coarse grains, wheat prices may become very competitive and the use of wheat as feed increases considerably. Additional demand functions for the United States, Canada, and the EC were created to allow for increased feed use when world wheat prices are low and wheat stocks are accumulating. The normal use of wheat as feed remains as part of the demand for total wheat. Thus, a low export price of wheat in exporting countries followed by an increase in stocks of wheat but no change in price of coarse grains tends to increase the demand for feed wheat. This, in turn, tends to reduce the export availability of wheat. However, a larger supply of wheat for feed competes with other grains used for feed. As a result, coarse grains prices are affected and export availability of coarse grains increases, assuming other conditions remain unchanged. All of these interrelationships are incorporated into the projection model.

In the developed countries, the demand for coarse grains is related directly to coarse grain prices and income. It would have been preferable to relate feed demand directly to production and consumption of livestock and livestock products. But this would have expanded the model considerably by requiring additional equations for the livestock sector.[26] However, in developing the price and income coefficients in the demand equation for feed grains, the influence of the livestock sector was taken into account implicitly.[27]

[25] See the discussion on South Asia, p. 62.

[26] An indication of the kind of expansion possible is the 60 equation model developed for the Japanese feed-livestock sector in the Filippello study (*41*).

[27] See app. B, p. 132, for the relationship between coefficients in the feed demand equation and coefficients in the supply and demand equation in the livestock sector.

Information on cross elasticities of demand for coarse grains is very limited. Even though empirical measurement has been largely negative, this study assumed that for certain regions substitution in demand does exist. In developing estimates of the price coefficients in the demand equations, allowance was made for consistency in substitution among the competing product (see p. 34). For example, a one-for-one relationship might be assumed between corn and rice if corn is being used directly for food. On the other hand, if consumption of rice is being substituted by consumption of meat and livestock products supported by corn, the ratio would be considerably higher depending on the type of livestock mix and source of livestock feed.

Price Equations

The price eqautions in the model serve two functions: (1) They provide the link between all of the supply, demand, and stock equations by relating the prices in these equations; and (2) they determine the degree of sensitivity between movements in two different prices (app. A, p. 111).

The degree of sensitivity is controlled by the coefficient relating the two prices. These sensitivity coefficients are shown in table 16. The coefficients may take on values of zero to one. A value of zero means there is no relationship between prices at two levels; while a coefficient of one assumed a one-for-one relationship. For example, a value of 0.3 (trade price sensitivity) in the wholesale-import price relationship for coarse grains was used in the EC. This assumes that for every dollar change in the world import price, the internal wholesale price for coarse grains in the EC will change by only 30 cents. When the sensitivity coefficient is equal to 1, the constant price in the equations becomes the margin between the two prices. Similarly, the demand-sensitivity coefficient related the consumer price level to the wholesale price level.

Interregional Price Relationships

These relationships link the 22 regions by trade prices for each commodity—wheat, rice, and coarse grains. In a sense, these three commodities are synthetic since each is comprised of a number of commercial grades or classes, all having a different market price. Hence, for each grain it was necessary to choose a respresentative grade, one which is widely traded on the international market. The price of this grade would act as a proxy for all grades and classes. The actual trade price in each region or country in the base year was then adjusted to a grade equivalent. The selected representative grade for wheat was U.S. No. 2 hard winter; for milled rice, No. 1, 5-15 percent broken; and for coarse grains, U.S. No. 2 yellow corn. Trade prices are either export (f.o.b.) or import (c.i.f.), depending on the net trade position of a region.

Because of the nature of the two models used for projecting at each market level, the interregional trade price relationships are expressed differently in each model. In model I, it was necessary to specify regional price relationships as:

$$(25)\quad PT_{ik} - PT_{ij} = M_{ijk}$$

Where PT_{ij} is the export price for commodity i in region j; PT_{ik} is the import price for commodity i in region k; and M_{ijk} is the export-import price margin for commodity i shipped from region j to region k. These margins were computed for the base period, then compared with the actual or estimated shipping costs between the trading regions and adjusted when necessary to reflect the shipping costs between the principal trading partners. The 21 regional relationships needed to link the 22 regions are shown in appendix A, page 121.

In model II, the regional relationships are a part of the solution.[28] As an input to this solution, a matrix of transportation costs is required.

Transportation Matrix

A matrix of transportation costs (ocean freight rates) is an essential part of model II. These costs are the coefficients of the objective function which assigns the minimum cost trade flows between the world regions subject to transportation and policy constraints.[29] Since the model has 22 regions, there are 484 possible trade flows including the flow from each region to itself. However, since the cost of shipment from each region to itself is assumed to be zero, the transporation matrix requires altogether 462 freight rates.

Published and available rates refer to only a few main shipping points; therefore, most of the rates had to be estimated. The range of variations in the available rates over time is great. The rates applied by U.S. flag vessels (which, by the Preference Cargo Act of 1954, have to be

---

[28] In model II, the trade price relationships are expressed as:

$$PTij - PBi = RPij$$

Where PTij may be either an export price or an import price for commodity i in region j; PBi is the base price for commodity i (one for each commodity); and RPij is the simplex multiplier (shadow price) for commodity i in region j. The simplex multipliers are dual variables from the transportation matrix part of the optimal solution and represent price differentials among shipping points. Additional technical information on the solution strategy of the relationship is given in ch. IV in the discussion of simplex multipliers (p. 27).

[29] The mathematical formulation showing how trade flows are determined is discussed in ch. IV, p. 26.

used for at least 50 percent of U.S. Government-sponsored grain shipments) are considerably higher than the rates applied by the foreign-flag tramp vessels; therefore, no direct competition exists between the two. Finally, although distance is important in determining rates, the major determinants are days in voyage and the shortrun relationships between the supply of and demand for shipping.

The Ocean Transportation Division of the Export Marketing Service, USDA, developed the transportation cost matrix used in the model (see app. table A1). The benchmark for the costs was published and known rates for heavy grains in bulk on foreign-flag vessels on the main established shipping routes in the last quarter of 1968. On the basis of these rates, other rates were estimated. Distance, the average time length in voyage between shipping points, and loading costs in the port of origin were taken into consideration. Thus, the matrix reflects a relative structure of transportation costs between the 462 shipping points rather than absolute freight rates.

Adjustments for Policy and Institutional Considerations

World trade is not always conducted in such a way as to minimize total shipping costs. Hence, to obtain more realistic trade flows, the model is constrained for policy and institutional considerations. There are three possible kinds of adjustments:

1. Direct adjustment of transportation costs. This can be used to reflect preferential treatment of trading partners, artificial trade barriers, or other special shipping arrangement.

2. Bounds imposed on trade flows. This can be used to the same effect as the adjustment of transportation costs but may be preferable if it is important to maintain the true values of simplex multipliers. Generally, bounds may be used to prevent certain trade flows from taking place or to force certain flows in order to bypass the net trade limitation of the model.

3. Additional constraints. Since the adjustment of transportation costs and the imposition of bounds may be too rigid for many policy and institutional adjustments of the model, the incorporation of additional constraints in the transportation matrix may deal with institutional and policy factors more realistically. In particular, international aid and stocks can be provided for in this way.

Because the projected trade flows closely followed the existing pattern of world trade, only minor adjustments were needed. The following are the adjustments introduced in the model:

1. Although rail rates between major U.S. and Canadian terminal markets amount to $11 per ton, the transportation cost between the two countries was calculated to be $4.10 to equalize it with ocean freight rates governing the trade of the rest of the world and to reflect the well-established trade arrangements between the two countries. Since both countries are grain surplus areas and no important trade flows between them, the rate of $4.10 represents an export price differential.

2. Although the EC (chiefly France) is a net exporter of wheat, it does import a considerable quantity of hard red winter wheat, principally from the United States and Canada, for blending. The quantity imported has been relatively stable in the past and is expected to remain stable in the future. Hence, to force this flow, a lower bound of 1 million tons each was imposed on U.S. and Canadian wheat imports to the EC.

3. It was assumed that, comparative advantages notwithstanding, Argentina will continue to maintain a certain share in the EC's coarse grain market. Hence, a separate constraint was added to the transportation matrix forcing 15 percent of the EC's demand for coarse grains to be satisfied from Argentine exports. This percentage is consistent with past experience.

4. Similar reasoning led to the formulation of the following additional flow-forcing constraints:

Wheat: From the United States to the United Kingdom, 10 percent of import demand and to South Asia, 30 percent of import demand. From Canada to South Asia, 30 percent of import demand and to Japan, 30 percent of import demand. From Argentina to West South America, 20 percent of import demand and to the United Kingdom, 20 percent of import demand. From the Soviet Union to Eastern Europe, 40 percent of import demand and to Western Asia, 20 percent of wheat exports. From Australia to Japan, 10 percent of import demand.

Rice: From Southeast Asia to the United Kingdom, 15 percent of import demand; to the EC, 25 percent of import demand; and to Eastern Europe, 30 percent of import demand.

Coarse grains: From the United States to the United Kingdom and South Asia, 50 percent of import demand of each. From Southeast Asia to Japan, 50 percent of exports. From Australia to Japan, 40 percent of exports.

Table 16.--World grain model: Sensitivity coefficients assumed in projections to 1980

Region	Wheat			Rice			Coarse grains		
	Supply	Demand	Trade	Supply	Demand	Trade	Supply	Trade	Demand
Developed:									
United States	0.6	1.0	0.4	0.6	1.0	0.4	0.6	1.0	0.8
Canada	1.0	1.0	0.8		1.0	1.0	0.5	1.0	1.0
EC	1.0	1.0	0.3	1.0	1.0	0.5	1.0	1.0	0.3
United Kingdom	0.3	1.0	1.0		1.0	1.0	0.3	1.0	1.0
Other W. Europe	0.5	1.0	0.5	0.5	1.0	1.0	0.5	1.0	0.5
Japan	0.3	1.0	0.9	1.0	1.0	0.2	0.2	0.5	1.0
Australia & New Zealand	1.0	1.0	0.8	1.0	1.0	1.0	0.6	1.0	0.8
South Africa, Rep. of	0.7	1.0	0.5	0.8	1.0	1.0	0.7	0.7	1.0
Central plan:									
Eastern Europe	0.3	0.8	0.1	0.3	0.7	0.8	0.3	0.5	0.1
USSR	0.3	0.7	0.1	0.3	0.7	0.8	0.3	0.5	0.1
Communist Asia	0.3	0.5	0.1	0.3	0.3	0.1	0.3	0.3	0.1
Less developed:									
Cent. Am. & Mexico	0.9	0.8	0.6	0.5	1.0	0.4	0.5	0.7	0.5
Argentina	0.6	0.7	0.8	0.8	0.7	0.5	0.8	1.0	0.7
East South America	0.4	0.7	0.3	0.5	1.0	0.5	0.5	0.8	0.7
West South America	0.5	0.7	0.3	0.5	1.0	0.5	0.5	0.8	0.4
East Africa	0.5	1.0	0.3	0.5	0.8	0.2	0.7	0.5	0.8
West Africa	0.5	0.7	0.2	0.5	0.7	0.2	0.5	0.7	0.2
North Africa	0.5	0.7	0.3	0.6	0.8	0.8	0.4	0.6	0.3
West Asia	0.7	0.8	0.5	0.6	1.0	0.8	0.5	0.8	0.5
South Asia	0.5	0.8	0.4	0.5	0.8	0.2	0.5	0.8	0.2
Southeast Asia	0.5	1.0	0.6	0.8	0.5	0.8	0.8	0.8	0.8
East Asia & Pacific Is	0.3	1.0	0.8	0.5	0.5	0.7	0.5	0.8	0.5

These adjustments affect directly the transportation matrix. Other policy and institutional constraints general to the model and affecting the level of stocks in the main exporting countries, the use of wheat for feed under certain price assumptions, foreign aid, and export policies are discussed elsewhere in this report.

Specific Assumptions

A number of economic and policy conditions that directly affect supply and demand are particularly applicable to major importers and exporters of grain. These will be specified and, unless noted otherwise, will hold for all projection sets. Specific assumptions have been made concerning price policies and the general directions and tendencies of price movements. However, the actual price under each projection set will be one of the products of the model.

Policies of Major Importers

An important feature of the import and domestic food production policies of major developed importers is that they attempt to at least maintain current self-sufficiency ratios.[30] Japan would be a major exception, since her self-sufficiency ratio seems destined to decline. For all other major developed importers, it is assumed that recent food and fiber policies will be continued. Some modifications were introduced where it appeared that a continuation of a particular policy would be untenable. These modifications, as well as the essentials of assumed food and fiber policies, are indicated below.

Japan.—While the overall consumption patterns for most of the developed area have become relatively stable, Japan's future pattern of food consumption could evolve in different directions. For one thing, the manner in which Japan deals with its rapidly rising food demand without excessive increases in food prices will depend on the type of food policy strategy taken. Policy decisions will largely determine the pace and extent of Japan's shift away from the traditional rice-based diet and toward a more diversified consumption pattern that includes more wheat and livestock products. And since increased consumption of wheat, feed for livestock production, as well as other food and fibers, must come from imports, Japan's trade policy will directly affect her agricultural imports. It is assumed that some limitations on imports will continue; however, enough imports will be permitted to prevent meat prices from rising too rapidly. For example, under projection set I, retail prices of meats are assumed to rise about 1 percent a year.

United Kingdom.—It is assumed that U.K. membership in the Common Market will not have been achieved by 1980[31] and that a continued balance-of-payments problem will push the United Kingdom in the direction of increased cereal production and continued limitations on consumption of other food and fiber products to minimize imports. Thus, low prices to consumers but higher ones to producers will be maintained by deficiency payments to producers. Producer prices for wheat and barley may rise about 15 percent above base levels, while prices of meat will rise sufficiently to encourage feeding of coarse grain.

Further, it is assumed that consumer prices will tend to follow world price levels as indicated by the use of 1.0 as a sensitivity coefficient in the wholesale-trade price equation. However, the use of 0.3 in the farm-wholesale price equation indicated U.K. farm prices to be fairly isolated from world price levels.

European Community.—It is assumed that the essentials for the present Common Agricultural Policy will be maintained—that is, high internal prices, import restrictions, and export subsidies and preferential tariffs on tropical products. It is also assumed that some modification and restructuring of agriculture will occur because of the high cost of maintaining the CAP; this will lead to some freer access to the EC market. The degree of access or the effectiveness of the variable levy system is reflected in the sensitivity coefficient used in the wholesale-import price relationship for wheat, coarse grains, and rice. Sensitivity coefficients of 0.3, 0.3, and 0.5, respectively, indicate some interaction between world and EC price levels.

Effective harmonization of producer prices would be completed in the early 1970's for all EC countries. The model provides for the internal wheat price to be reduced from the base period level and to move toward the level of coarse grain prices (corn and barley). At the same time, some increase from base period levels is assumed for producer coarse grain prices, particularly corn. Domestic coarse grain prices are expected to be high enough to encourage a shift in production from wheat to coarse grains but low enough to maintain coarse grains in a favorable price position for feeding.

The projections assume that EC livestock prices will continue to rise relative to feed costs to encourage expansion of meat production to satisfy the increasing demand for meat. If the dual purpose cow is maintained, an expansion of meat production could lead to further surpluses of milk. However, it is assumed that special programs, possibly of the type initiated in 1969,

[30] Self-sufficiency ratio is the relationship of the domestic production of a commodity to the total domestic supply of that commodity.

[31] At time of publication, the U.K. voted to join the EC. Such action would result in higher price levels than assumed in this study.

will be adopted to limit commercial production of milk and to encourage the shift from dairy cattle to beef cattle.[32] Specifically, the choices will be in the direction of shifting from dual purpose cows to beef cattle rather than unduly raising meat prices to curb meat consumption.

It is assumed that a considerable amount of wheat will continue to be used as feed in the EC. A kinked demand curve is assumed for wheat. At normal price relationships between EC and world levels, variations in the quantity of wheat fed are considered as part of the total (food and feed) demand equation for wheat. However, if the world wheat price falls substantially, the EC subsidy cost of exporting surplus wheat rises considerably. At some point thereafter, it becomes more efficient to shift wheat supplies to feed uses rather than export them. An additional source of supply for feed then becomes available. In the projection model, such an additional amount of wheat used for feed in the EC is related directly to the EC export price of wheat. Thus, when the world price and the EC export price fall substantially, more wheat is diverted to feed uses in the EC. This, in turn, results in a lower derived demand for barley, corn, and other feed grains. As a result, the lowering of the world wheat price level will result in reducing the import demand for coarse grains in the EC. The specific equations to accomplish this are shown on page 120.

Other Western Europe.—Most O.W.E. countries have maintained a high-price policy to achieve self-sufficiency in wheat production. The price level ($100-$110 per ton) is such that it has been encouraging a growing surplus of wheat. Wheat surpluses in recent years have been exported under subsidies. For example, Spain exported wheat to Argentina in 1968 at an f.o.b. price of around $55 per ton. It is assumed that O.W.E. countries would lower internal prices sufficiently to minimize export availabilities of wheat. Thus, producer prices for wheat are expected to be lower relative to coarse grain prices. Even if a high nominal support price is maintained in some countries, the effective average price received would be lower if the quality requirements of eligible wheat for support were raised. The policy would also encourage shifts of farm resources to coarse grain production where feasible. It is projected that O.W.E. import requirements for coarse grains will continue to rise despite some increase in producer prices that would encourage domestic coarse grain production to rise.

[32] In fall of 1969, the EC Ministers of Agriculture approved measures to limit production of milk through payment for cow slaughter and nonmarketing premiums.

Policies of Major Exporters

Two considerations that are of utmost importance in the policies of major exporters are basic to the assumptions of this study. The first is price maintenance at reasonable levels and applies to projection sets I, II, and III. The second is market share maintenance and applies to projection sets II-A and II-B (these are defined in ch. VIII, p. 63). It is not always possible to achieve both of these objectives at the same time. During periods of heavy world supplies, prices cannot be maintained unless importers as well as exporters collaborate to curtail production.

While emphasis is on world price stability, it is assumed that moderate variation in prices will result when world supplies are in relatively short supply or in heavy surplus. It is further assumed that the major exporters will maintain a stock and production policy to support this relative price stability. Implementation of this policy could be achieved through international cooperation.[33]

United States.—Export policies of the United States—the major exporter of wheat, rice, and coarse grains—exert a dominant influence in world trade. Under projection set I, it is assumed that the U.S. export policy is fairly responsive to changes in world supply and demand conditions for all three grains. The U.S. sector model does not attempt to represent explicitly the voluntary wheat and feed grain programs or the rice program in effect. However, the combination of the coefficients in the supply functions, the demand equations for storage, and the demand equations for feed wheat assumes that reasonable stability will be maintained in the U.S. export price of wheat and coarse grains. For wheat and rice, it is assumed that export payments or subsidies will be part of the program to provide flexibility in domestic prices while maintaining an export policy of relative world price stability. For example, the use of 0.6 for the supply sensitivity coefficients indicates that domestic supply prices do not follow fully international prices so that variable subsidies or export payments would be necessary. On the other hand, because U.S. feed grain exports comprise only a small part (about 15 percent) of domestic production and because the domestic demand for feed grains is less inelastic than that for either wheat or rice, changes in world supply and demand conditions have less effect on U.S. price levels. However, since the United States is the largest exporter of feed grains, its price policies affect world price levels significantly.

[33] See ch. III, p. 14 for the discussion on the IGA and IWA.

Canada.—It is assumed that Canada will continue to maintain domestic wheat policies in accord with the overall policy objectives of major exporters. As indicated above, this policy puts considerable emphasis on price stability. In essence, Canada will try to maintain its export price of $65-$70 per ton for No. 1 Northern at Fort Williams-Port Arthur.[34] It is assumed that the Canadian Grain Board will adjust its policies to reduce exports (reduce delivery quotas) when world wheat prices are low and to increase exports when world prices are high. The immediate consequence of this policy, for a given level of production, would be to add to storage when export prices are falling and to withdraw from storage when prices are relatively high.

It is assumed that the bulk of the wheat will be stored by farmers. Thus, an increase in storage stocks will tend to have the effect of decreasing the net returns from producing wheat. Consequently, an increase in the level of wheat stocks owned by farmers will tend to reduce wheat acreage, while a decrease in stock levels will tend to encourage expansion of production. The projection model incorporates the influence of stock levels on production by specifically introducing the stock variable into the production function. It also has a separate relation for the demand for storage in Canada. This relation relates the change in stock levels during any year to production levels and export price levels.[35]

It is assumed that as long as the capacity to produce wheat continues to exceed consumption at "reasonable" prices to producers, there will continue to be a high level of stocks. Further, the level of stocks is assumed to increase over time by around 7 million tons above the base period level of 15 million tons. Thus, on the average, there would be an accumulation of roughly 0.500 million tons a year. The assumed stock level of 22 million tons in 1980 is approximately the same as that on July 1, 1969.

It is further assumed that the continued wheat production capacity excess over world needs will tend to cause some slippage in achieving policy objectives, although Canada's policy objective will be to achieve a production-consumption balance at roughly base period price levels.

Thus, it is estimated that at wheat prices comparable to base period prices, a rate of accumulation of 2 million tons in stocks will occur which will either be fed or set aside for aberations from long run equilibrium. Specifically, the model assumes that there is a tendency for stocks to accumulate, but explosive situations are avoided because of unexpected market demand from time to time, as for example the imports by the USSR and South Asia in the mid-1960's.

The model also has a special demand equation for feed wheat when stocks of wheat begin to accumulate. These stocks then become a source of supply in the coarse grain sector in Canada. Thus, as wheat stocks increase, use of wheat as feed would increase. This increase, in turn, reduces domestic coarse grain use, but increases the export availability of coarse grains.

Australia.—It is assumed that grain production policies in Australia will also be sensitive to world prices and be consistent with maintaining relative world price stability. As in the case of Canada, wheat production is assumed to be influenced by stock levels; thus, the stock variable is included in the supply function for Australia. In turn, the demand for stocks is related to wheat production and the wholesale price of wheat. Since the wholesale price of wheat is related to export price, the level of stocks is affected by the world demand situation.

Argentina.—It is assumed that Argentina will not maintain large stocks of grain and that grain production is quite sensitive to world prices.

South Asia.—For most regions of the world, the demand functions have the usual price, income, population, and trend factors. However, for South Asia these factors are not sufficient to explain variations in demand because the amount consumed of each grain is also a function of availability. For example, the relative amount of wheat or rice that will be consumed in the 1980's in India will depend on relative improvements in production technology for the two grains. If technology is more favorable to wheat than to rice, wheat consumption will rise considerably faster than rice consumption. If technology in rice production increases faster, rice consumption will increase faster.

It is assumed that the total substitution effect between wheat and rice cannot be fully expressed by the use of prices alone. A further assumption is that any shortfall between production and consumption of grains will primarily be made up from wheat imports. Thus, production of rice as well as wheat will affect the consumption and trade of wheat. The production variables for wheat, rice, and coarse grains were added to the demand equations for wheat, rice, and coarse grains to account for these substitution effects directly. These additions assumed that the effect of rice production on wheat consumption is considerably more than the effect of wheat production on rice consumption. Some of the shortfall in the production of all three grains would be compensated by imports of wheat. For example, a 10

[34] Fort William—Port Arthur is now Thunder Bay.

[35] See p. 40 for the influence of production and export price on stocks.

million-ton shortfall in rice production results in 6.5 million tons of wheat imports.

It was assumed that coarse grain consumption would not be affected directly by wheat and rice production. However, the inclusion of prices for wheat, rice, and coarse grains in each of the demand functions accounts for some substitution between wheat, rice, and coarse grains. The substitution effect represented by prices may be considered to represent the normal substitution in consumption, while the additional effect of substitution introduced by the production variables represents substantial shifts due to technological change.

VIII.—PROJECTIONS OF DEMAND, SUPPLY, AND TRADE

As mentioned in chapter VII, three basic projection sets were constructed for all grains. Projection set I assumes a continuation of current policies, which includes stabilization of world prices. Under projection set II, which assumes an acceleration in the production growth of the less developed countries, the annual growth rate in grain production of the LDC's used in set I is increased by a factor of 1.4 over that of set I. Under projection set III, which assumes that the Green Revolution fails, production in the LDC's drops below the level of set I by a factor of 0.7.

In addition, subsets II-A and II-B were used to test the effects of two major policy changes. A market share assumption was envoked under II-A to determine what might occur if the major developed exporters adopt a rigid policy to maintain their traditional share of the world market. Under II-B, it is assumed that the developed importers become more sensitive to world grain prices and adjust their high internal prices.

The discussion of the projection sets takes the following course (see fig. 2). Demand, supply, and trade projections to 1980 under set I are compared with 1964-66 base period averages, and long-term changes during the 15-year period are highlighted. Then, results of set II and III are compared with those of set I to test the effects of alternative policies or economic trends on export earnings.

In the individual studies of wheat, rice, and coarse grains (*71, 80, and 116*), the influence of population, income growth, and other underlying factors were tested in relation to prices. In all three of these studies, a projection set assumed that prices would remain at the 1964-66 level. Results from those projection sets indicate that 1980 world grain supplies could exceed demand; this supports the conclusions of an earlier USDA study (*3*). In that study, the potential exportable world grain surplus projected for 1980 was between 30 million and 63 million tons, depending on the production growth assumptions for the LDC's. The same study also projected an exportable surplus of 78 million tons for the developed world, if the reserve acreage in the United States were planted to grain.

Similar conclusions can be drawn from an OECD study (*110*) which assumed continuation of recent price trends and projected an exportable surplus of 90 million tons in 1975 and 121 million tons in 1985 for the developed world. A recent FAO study (*55*) of 40 LDC's concluded that the less developed world had the productive capacity to return before 1985 to its pre-World War II position as a major exporter of cereals. The study further indicated that if the LDC's were to attain the targets projected by the Indicative World Plan (IWP), a reduction of 10 to 15 percent in area devoted to grains in the developed world would be needed to accommodate the exportable surplus of the LDC's.

All these studies indicate that world grain supplies could exceed demand at current price levels, resulting in downward pressures on price in the 1970's. Thus, price and supply adjustments would be needed to keep exportable supplies in reasonable balance with import requirements.

Projection Set I

Projection set I assumes the continuation of current policies, which include stabilization of world grain prices.

Wheat

Under projection set I, the major developed grain exporters—the United States, Canada, and Australia—would adjust their supplies and export policies to maintain buoyant world trade prices (table 17). Wheat production in these countries could increase at only a modest annual rate of 1 percent—substantially below potential growth—because prices come under downward pressures. This projected situation arises from both supply and demand developments.

Wheat production in the less developed importing countries, with impetus from the Green Revolution, would increase 4.4 percent annually.[36] Much of this high rate is attributed to South Asia (India and Pakistan), which should expand output rapidly if its

[36] If base period production is adjusted upward to trend level to offset the severe droughts of 1965 and 1966 in South Asia, the rate would be 3.7 percent. Annual growth rates calculated from data using an adjusted base are shown in tables 25-30 for wheat, rice, and coarse grains. Annual growth rates in the text are obtained from the adjusted base, unless noted otherwise.

A SEQUENCE FOR WORLD GRAIN PROJECTIONS

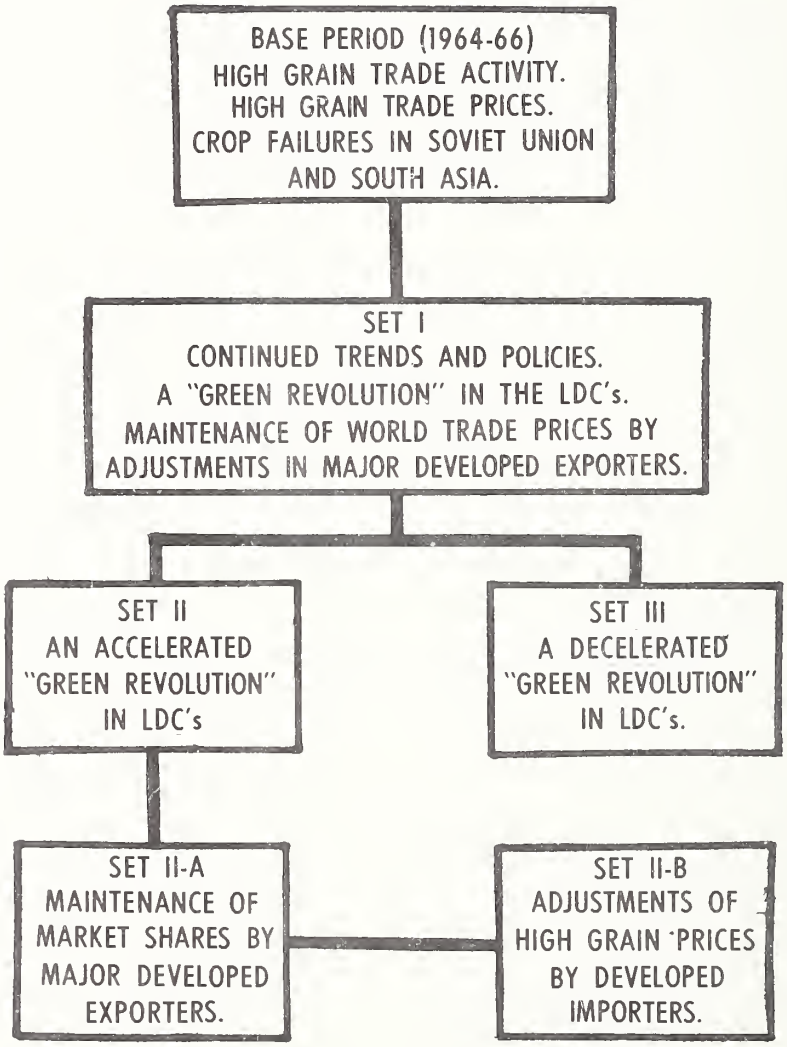

Figure 2

Table 17.--Wheat: Production, consumption, and trade, 1964-66 average, and projections to 1980 under projection sets I and II 1/

Region	1964-66			1980--proj. set I			1980--proj. set II		
	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/
	Million metric tons								
Developed:									
Importers--									
EC	28.8	27.7	1.3	36.0	32.1	3.9	35.9	33.4	2.4
United Kingdom	3.8	8.2	-4.3	4.5	8.9	-4.5	4.4	9.0	-4.6
Other W. Europe	10.2	11.5	-1.3	11.2	10.7	.5	11.2	10.6	.6
Japan	1.2	4.8	-3.6	.8	7.3	-6.5	.8	7.3	-6.5
South Africa, Rep. of	.8	1.1	-.4	1.3	1.8	-.5	1.3	1.8	-.5
Subtotal 3/	44.8	53.3	-8.4	53.7	60.8	-7.1	53.6	62.1	-8.5
Major exporters--									
United States	35.5	18.6	21.2	43.2	22.5	19.3	42.8	24.9	14.8
Canada	18.8	4.2	13.8	18.6	4.3	11.9	17.6	4.7	8.7
Australia and New Zealand	10.2	2.7	6.3	11.1	2.8	7.8	10.4	2.8	6.8
Subtotal 3/	64.5	25.5	41.4	72.9	29.6	39.0	70.8	32.5	30.3
Total, developed 3/	109.3	78.8	33.0	126.6	90.4	31.9	124.5	94.6	21.8
Central plan:									
Eastern Europe	20.8	26.6	-5.7	30.7	32.5	-1.8	30.7	32.5	-1.8
USSR	63.1	65.5	-2.4	84.3	79.7	4.6	84.3	79.7	4.6
Communist Asia	22.9	28.6	-5.7	36.0	42.1	-6.1	36.0	42.1	-6.1
Total, central plan 3/	106.8	120.7	-13.8	151.0	154.3	-3.4	150.9	154.3	-3.4
Less developed:									
Importers--									
Cent. Am. & Mexico	1.9	2.9	-1.0	3.2	5.5	-2.3	4.0	6.1	-2.1
East South America	.8	3.8	-3.0	1.2	6.1	-4.9	1.3	6.3	-5.0
West South America	1.6	2.8	-1.2	1.9	5.3	-3.4	2.1	5.6	-3.5
East Africa	.5	.8	-.3	.8	1.5	-.7	.9	1.6	-.7
West Africa	4/	.7	-.6	4/	1.5	-1.5	4/	1.7	-1.6
North Africa	4.1	7.7	-3.6	5.3	14.3	-8.9	5.7	15.3	-9.6
West Asia	12.5	14.4	-1.9	17.9	22.9	-5.0	20.0	24.4	-4.3
South Asia	17.3	26.7	-9.3	43.6	46.0	-2.4	59.9	52.8	7.1
Southeast Asia	4/	.3	-.2	.1	.5	-.4	.1	.6	-.4
East Asia & Pacific Is.	.3	2.4	-2.1	.5	4.6	-4.2	.5	4.9	-4.4
Subtotal 3/	39.1	62.4	-23.3	74.4	108.2	-33.8	94.6	119.2	-24.6
Major exporters--									
Argentina	7.9	3.9	5.1	9.9	4.7	5.2	10.6	4.4	6.2
Total, less developed 3/	47.0	66.3	-18.2	84.3	112.9	-28.6	105.2	123.6	-18.4
World total 3/	263.1	265.7	.9	361.8	357.6	4/	380.6	372.6	4/

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in set I.
2/ Some regions do not balance because of stocks.
3/ May not add because of rounding.
4/ Less than .05 million.

semidwarf wheat program continues to be successful. Wheat production in Argentina is expected to grow 1.5 percent annually, which is not high compared with the other LDC's but is still well above trend.[37] With a projected growth in production of 2.1 percent a year, the Soviet Union should be able to build up stocks from the low levels of the base period. The projected growth in output for the developed importers is 1.2 percent; this rate is generally below trend because of an expected shift to production of coarse grains.

Wheat consumption in the LDC's is projected to increase 3.9 percent a year, reflecting a high rate of population growth and a strong positive demand response to income growth. It is important to note that the projected growth in demand is higher in this area than in either the developed or central plan area. But for the developed area, the projections reflect a sluggish demand. Population growth is relatively low and except for Japan, there is generally a negative demand response to income growth. For the major exporters and the developed importers, excluding Japan, projected consumption increases only 0.8 percent a year. In these countries, the growth in wheat demand comes primarily from increased feed use. But for Japan, consumption of wheat would increase 3.1 percent annually, reflecting a strong response to income and substitution of wheat for rice.

The most surprising trade development for wheat under set I is a 45-percent increase in net imports for the LDC's. What makes this trend more pronounced is that the imports of South Asia, traditionally the largest wheat importer, decline from the very high level of 9.3 million tons in the base period to 2.4 million tons in 1980.[38] Substantial increases in import demand for wheat are projected for Central America, East and West South America, North Africa, and West and East Asia—areas of potential income growth but not ideally suited for large increases in wheat production.

Net imports for the developed importers as a whole would decline, largely as a result of lagging demand but also because of expanding production. Net exports in the EC could triple the base period level of 1.3 million tons.[39] Other Western Europe is projected to shift from a significant net import to a small net export postition. But Japan would remain a growing market, with imports increasing to 6.5 million tons, about 80 percent above the base level.

Trade in the central plan area also would change markedly, with the Soviet Union shifting from a net importer in the base period back to its traditional net export role. Her main market would continue to be Eastern Europe, but the markets of North Africa and West Asia could become more important.

Canada's loss of the USSR market would be partly offset by substantial increases in wheat exports to Mainland China and Latin America. Thus, although the projected Canadian exports of 11.8 million tons will be significantly above the levels in the late 1960's, they will be below the 15 million-ton level of the base period, when one-third of Canada's wheat exports went to the USSR.

The growth in exports from Australia in the 1960's is expected to continue in the 1970's. Favorable factors promoting this growth are proximity to the growing wheat markets in rice-consuming countries in the Far East and Mainland China, and the competitive advantage of the lower grade wheat in these areas.

The net result of these trade changes as they affect the major exporters would be nearly offsetting; their exports of 44.2 million tons would be down slightly from the base period but significantly higher than in the late 1960's.

Rice

Under projection set I, the expected production patterns for rice are similar to those for wheat. There is capacity to expand production in the developed world, but a sluggish import demand would be a depressant on world prices and lead to production adjustments. These would be most apparent for the United States, the major exporter in the developed area, and Japan, which accounts for close to three-fourths of the developed area's production. U.S. rice production would increase 1.5 percent annually, which is substantially below the historical trend (table 18). Japan's projected output is 11.1 million tons, which is slightly below the 1964-66 average; declining per capita consumption is largely responsible for maintaining output at a relatively stable level. On the other hand, the projected annual growth in output for the LDC's is relatively high: 2.8 percent for the importing regions and 2.5 percent for the exporters. These rates, which are considerably above past trends, would be due in large part to realized potential of the high-yielding rice varieties and production programs associated with the Green Revolution.

Consumption of rice in the developed area, excluding Japan, is expected to increase 1.8 percent a year, reaching 3 million tons by 1980. But consumption in Japan is expected to decline from 11.9 million to 11.3 million tons as a result of a 20-percent drop in per capita utilization. This trend reflects a shift from rice to wheat as income in Japan rises.

[37] If base period production is adjusted for the unusually high level of 1966, the rate would be 2.4 percent.

[38] The reader is reminded that the base period includes the 2 severe drought years that resulted in massive food aid shipments.

[39] The EC would continue to import hard wheat at about a level of 2.0 million tons from the United States and Canada.

Table 18.--Rice: Production, consumption, and trade, 1964-66 average, and projections to 1980 under projection sets I and II 1/

Region	1964-66			1980--proj. set I			1980--proj. set II		
	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/
	1,000 metric tons								
Developed:									
Importers--									
Canada	--	45	-45	--	64	-64	--	66	-66
EC	453	654	-199	469	771	-302	448	784	-336
United Kingdom	--	109	-109	--	134	-134	--	140	-140
Other W. Europe	422	455	-29	527	567	-40	505	587	-82
Japan	11,447	11,923	-750	11,124	11,294	-170	10,987	11,352	-365
South Africa, Rep. of	2	75	-73	5	137	-132	5	142	-137
Subtotal	12,324	13,261	-1,205	12,125	12,967	-842	11,945	13,071	-1,126
Major exporters--									
United States	2,553	963	1,527	3,255	1,287	2,063	3,210	1,297	147
Australia & N.Zealand	136	44	71	235	77	158	222	82	140
Subtotal	2,689	1,007	1,598	3,490	1,364	2,221	3,432	1,379	287
Total, developed	15,013	14,268	393	15,615	14,331	1,379	15,377	14,450	-839
Central plan:									
Eastern Europe	99	389	-290	128	482	-354	125	492	-367
USSR	341	588	-247	1,221	1,487	-266	1,214	1,501	-287
Communist Asia	63,927	63,024	903	88,518	87,750	768	88,381	87,807	574
Total, central plan	64,367	64,001	366	89,867	89,719	148	89,720	89,800	-80
Less developed:									
Importers--									
Cent. Am. & Mexico	665	1,032	-367	1,312	1,815	-503	1,693	2,087	-394
West South America	853	924	-71	1,486	1,508	-22	1,864	1,764	100
East Africa	1,019	1,199	-177	1,448	1,902	-454	1,653	2,090	-437
West Africa	1,301	1,729	-428	1,851	2,642	-791	2,146	2,783	-637
West Asia	921	1,275	-354	1,524	2,099	-575	1,848	2,312	-464
South Asia	45,868	47,005	-1,137	70,723	71,493	-770	80,886	81,003	-117
East Asia & Pac. Is.	17,867	19,595	-1,728	29,301	30,928	-1,627	34,841	35,887	-1,046
Subtotal	68,494	72,759	-4,262	107,645	112,387	-4,742	124,931	127,926	-2,995
Major exporters--									
Argentina	141	118	29	250	207	43	300	219	81
East South America	4,891	4,509	382	7,406	7,248	158	8,674	8,295	379
North Africa	1,301	960	341	2,310	1,772	538	2,782	2,120	662
Southeast Asia	18,215	15,951	2,419	25,303	22,823	2,480	26,673	23,882	2,791
Subtotal	24,548	21,538	3,171	35,269	32,050	3,219	38,429	34,516	3,913
Total, less developed	93,042	94,297	-1,091	142,914	144,437	-1,523	163,360	162,442	918
World total	172,422	172,566	-332	248,396	248,487	4	268,457	266,692	-1

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in set I.

2/ Some regions do not balance because of stocks.

Utilization of rice in the LDC's is projected to increase 50 percent over the 1964-66 average, mainly because of population growth. The annual per capita gain for the LDC's is only 0.1 percent, but this low average is heavily influenced by the slow growth in South Asia and Southeast Asia. Annual growth rates for other LDC regions range from 0.2 to 2.2 percent. Expanding wheat production and consumption would tend to hold down rice consumption. This is particularly true for South Asia, which accounts for close to half of rice consumption in the less developed area.

Given the projected level of supply and demand, Japan's 1980 rice imports are expected to fall sharply from the 0.8 million tons of the base period.[40] By the late 1960's, Japan had already faced an over-supply problem which resulted in its shift to a net export position. Short run surpluses may occur again with a self-sufficiency policy in rice. However, Japan is a high-cost rice producer and continued production of rice at surplus levels would be too expensive to maintain as a national policy.

For other developed importers, rice imports are expected to increase about 50 percent, reaching 0.7 million tons (net basis). Even if the projected imports of 0.6 million tons for Eastern Europe and the USSR are added, the resulting import total of 1.3 million tons is less than a fourth of projected world rice trade of 6.2 million tons. Only a modest increase over base period imports was projected for the USSR. The increase could be greater if the USSR resumed importation of rice from China.

Because the demand for rice is inelastic and the developed importer's share of the world market is relatively small, these importers cannot absorb any significant increase in supplies of exporters unless substantial price concessions are made. More important, 1980 rice consumption in Eastern Europe, the Soviet Union, and the developed area, excluding Japan, is projected at 5 million tons, or only about 2 percent of world consumption. Thus, it is not surprising that any significant change in the volume of exportable supplies results in substantial changes in world prices of rice. About half of this market is expected to be supplied by the developed exporters.

Thus, the LDC's are projected to be the major import market for rice, taking 4.7 million of 6.2 million tons exported. More than half of the LDC imports would be supplied by less developed exporters. The United States, Australia, and Communist Asia would supply most of the remainder. However, LDC importers in the aggregate would increase their rice imports only modestly from the base period level since gains in output would about match growth in demand. Substantial increases in import demand are projected for Central America, West Asia, and East and West Africa. But because of the expected increases in production in India, Pakistan, and Ceylon, these increases are offset by South Asia.

Projected rice exports for Southeast Asia of 2.5 million tons are near the 1964-66 level and substantially above the level of the late 1960's, but they are still a third below the 1959-61 level. This region, which includes Burma, Thailand, Cambodia, and South Vietnam, has traditionally been the leading rice exporter but experienced difficulties in the 1960's that caused exportable supplies to drop substantially. Military conflicts have been disruptive in some of the countries and rice production in others has simply not kept pace with the growing domestic demand. Should these problems be resolved, chances are good that exportable supplies would be well above the level of set I.

North Africa (mainly the UAR), the other major exporting region in the less developed area, is projected to increase exports substantially over the base period. The USSR has been a growing market for this region. In turn, the USSR is expected to export large quantities of wheat to the UAR.

The United States, which increased its share of the world market in the 1960's when exports from Southeast Asia faltered, should continue to increase its export market. Much of the expected market growth is contingent on the availability of favorable trade terms (concessional sales) and the rate of recovery of rice exports from Southeast Asia.

Coarse Grains

In contrast with set I projections of wheat and rice production, coarse grains production in the developed exporting regions rises substantially. And world prices are not expected to be under as much downward pressure as projected for wheat and rice. Production of the developed exporters, responding to demand, is projected to increase 2.6 percent annually. In developed importing countries, which generally are expected to continue to have self-sufficiency objectives and high internal prices, output is expected to increase at an even higher annual rate of 2.7 percent. In particular, output in the EC and the United Kingdom is expected to increase at 3.0 and 3.1 percent, respectively.

Coarse grain output in importing LDC's is expected to increase 2.5 percent a year by receiving some benefit from the Green Revolution, although most of its thrust would be directed to wheat and rice. But production in less developed exporting countries is projected to increase at a high annual rate of 3.3 percent. A large percentage increase is expected in Southeast Asia

[40] Japan is expected to continue to import glutenous rice, which is not produced domestically.

Table 19.--Coarse grains: Production, consumption, and trade, 1964-66 average, and projections to 1980 under projection sets I and II 1/

Region	1964-66			1980--proj. set I			1980--proj. set II		
	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/
	Million metric tons								
Developed:									
Importers--									
EC	30.9	43.0	-11.9	50.7	60.8	-10.0	50.6	59.9	-9.3
United Kingdom	9.5	13.0	-3.5	14.5	16.3	-1.7	14.4	17.3	-2.9
Other W. Europe	19.4	24.9	-5.6	28.1	33.2	-5.1	27.9	34.1	-6.2
Japan	1.4	7.5	-6.0	1.0	17.7	-16.7	1.0	18.2	-17.2
Subtotal 3/	61.2	88.2	-26.9	94.4	128.0	-33.6	94.0	129.5	-35.6
Major exporters--									
United States	136.6	124.5	21.8	210.5	179.8	30.0	206.9	184.2	21.0
Canada	14.1	13.5	.7	18.3	17.3	1.1	18.1	17.7	.4
Australia and New Zealand	3.1	2.4	.7	6.3	3.5	2.8	6.2	3.6	2.7
South Africa, Rep. of	5.1	4.6	.5	11.0	7.1	3.9	10.8	7.3	3.4
Subtotal 3/	159.0	145.0	23.6	246.2	207.7	37.8	242.0	212.8	27.5
Total, developed 3/	220.1	223.4	-3.3	340.6	335.7	4.2	335.9	342.4	-8.1
Central plan:									
Eastern Europe	44.0	44.4	-.4	55.5	54.5	1.1	55.5	54.4	1.0
USSR	51.6	51.3	.3	78.0	77.2	.7	77.9	77.3	.6
Communist Asia	46.9	46.8	.1	66.5	66.8	-.3	66.4	66.8	-.4
Total, central plan 3/	142.5	142.5		199.9	198.4	1.5	199.8	198.6	1.2
Less developed:									
Importers--									
Cent. Am. & Mexico	11.1	10.5	.7	18.0	20.2	-2.2	22.1	22.7	-.7
West South America	2.8	2.9	-.1	3.2	4.4	-1.2	3.3	4.5	-1.2
West Africa	11.1	11.1	.1	14.0	16.8	-2.8	15.4	17.6	-2.2
North Africa	6.4	6.5	.1	11.1	12.1	-1.0	13.1	13.5	-.4
West Asia	8.3	8.8	-.5	11.0	13.8	-2.8	12.1	14.6	-2.6
South Asia	25.8	27.2	-1.3	37.0	39.8	-2.8	41.4	43.8	-2.4
East Asia & Pacific Is.	6.4	6.8	-.3	12.0	15.7	-3.7	15.3	16.7	-1.3
Subtotal 3/	72.0	73.6	-1.6	106.3	122.8	-16.6	122.7	133.5	-10.7
Major exporters--									
Argentina	9.0	3.9	5.2	13.4	6.4	7.0	15.1	6.7	8.4
East South America	11.6	11.3	.2	20.1	19.1	1.0	23.8	20.7	3.0
East Africa	12.1	12.2	-.1	20.0	18.8	1.2	23.8	20.6	3.3
Southeast Asia	1.4	.2	1.3	3.5	1.9	1.6	4.9	2.0	2.9
Subtotal 3/	34.1	27.6	6.6	57.0	46.2	10.8	67.6	49.9	17.6
Total, less developed 3/	106.1	101.4	5.2	163.3	169.0	-5.8	190.3	183.4	6.9
World total 3/	468.7	477.0	1.7	703.8	703.1		726.0	724.3	

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in Set I.

2/ Some regions do not balance because of stocks.

3/ May not add because of rounding.

following efforts of Japan to expand its sources of supply and its market for industrial products.

The long-term developments of the supply and distribution of coarse grains will be highly influenced by rising consumer incomes, which should stimulate the demand for meat and livestock products. Growth in such demand in the developed exporting regions accounts for much of their projected increase in production, although their exports are also expected to rise substantially above base period levels.

In Japan, most of the increase in demand for livestock products will be reflected in rising imports of coarse grains and other feeds. Limited room for growth in domestic grain production and continued restrictions on meat imports should encourage increased feed imports. Prices of livestock products are expected to rise, thus slowing down the potential growth in meat consumption. But favorable product-feed price ratios should encourage livestock production and consequently grain requirements and imports. Japan's coarse grain imports are expected to almost triple the 6.0 million-ton level of the base period. The United States would continue as the major supplier of this market, increasing substantially its share of the Japanese market under projection set I.

Demand for meat in the EC is also expected to increase substantially, but the increase is not expected to be fully reflected in a corresponding rise in coarse grain consumption. The maintenance of relatively high coarse grain prices in the EC under projection set I may continue to encourage the substitution of feed wheat and other feedstuffs (grain byproducts, high-protein meals, cassava chips, soybeans, and beet pulp). The high-price policy should also encourage substantial increases in coarse grain production. As a result, 1980 net imports of coarse grains by the EC are expected to be a little below the high level of 11.8 million tons in the mid-1960's but higher than in the late 1960's. As previously indicated, it was assumed that because of the high cost of the CAP to the member countries, there would be some restructuring of prices and freer access to the EC market. With the advent of the EC's Common Agricultural Policy, producer price levels for coarse grains have generally been higher and the price relationship between wheat and coarse grain has narrowed. These changes have been responsible for sharp increases in production of coarse grains, particularly corn.

Given a level of coarse grain demand, EC imports are also affected by the quantity of wheat available for feeding. Under set I, a substantial increase in EC wheat exports is projected. If some of this wheat were fed, an equivalent reduction in imports of coarse grains would result. However, the import level of total grains would not be affected materially. The net import position of EC for total grains is 6 million tons (table 23). But continuation of recent production and trade developments could lead to a net self-sufficiency in total grains for the EC. Present price levels for coarse grains in the EC are higher than the levels projected under set I.

Demand for coarse grains is also expected to increase substantially in the United Kingdom and Other Western Europe, but increased production, particularly in the United Kingdom, may more than offset the expected growth in demand. Consequently, net imports for set I are expected to drop by about 2 million tons for the United Kingdom and by a half million for Other Western Europe. Thus, with the exception of Japan, the projected import market in the developed area for coarse grains should remain sluggish.

Consumption of coarse grains in Eastern Europe and the USSR is expected to rise moderately as a result of an expansion in their livestock sector. Increased production, however, should more than cover domestic requirements. And both regions could be significant net exporters by 1980.

Another surprising development under set I is a projected 15 million-ton increase in import demand for coarse grains in the LDC's. Some countries in Asia—especially Israel, Taiwan, and South Korea—will expand feed grain imports significantly. Countries of North and West Africa, of Central America, and of South Asia could also develop as important outlets of coarse grain exports. The increase in LDC imports would result largely from the strength of the two prevalent demand factors—population and income. Increased consumption of livestock products should become more evident in poultry consumption. The growth in import demand thus presupposes an expansion of poultry plants. The feed inputs to these plants would be imported grains because of lower costs and the difficulty of moving domestic grain from the interior. The level of LDC imports, however, would hinge upon the availability of concessional trade terms.

Projection Set II

Under projection set II, which might be termed "accelerated Green Revolution conditions," the annual growth in grain production in the LDC's was assumed to increase over the rate used in set I by a factor of 1.4. This acceleration would be expected to trigger growth in income and the demand for grains. The basic assumptions for set I other than production growth hold for set II. This section will highlight the major differences between projections of sets I and II.

Wheat

The gains in wheat output for the LDC's would exceed the additional demand generated by the higher rate of income growth of set II. LDC wheat imports would therefore decline sharply from the levels under set I. South Asia accounts for nearly all of the decline, shifting from a net importer of 2.5 million tons to a net exporter of 7 million tons. The increased availability of wheat for export in South Asia is also influenced by the assumed increase in rice production. Substitutions of rice for wheat would hold down the amount of increased wheat output that could be absorbed by domestic consumption.

Shipments of the major exporters would drop by about 9 million tons to support the assumed price maintenance policy. Thus, under set II, U.S. exports of wheat would decline 4.5 million tons from the level under set I. Equivalent declines of 3.2 million and 1.0 million tons could be expected for Canada and Australia. Similar declines in exports were experienced by Canada and the United States in the late 1960's following Canada's loss of the USSR market and the reduction of import requirements in India. Consequently, under set II conditions, the export market for wheat would weaken; the price of wheat would fall relative to that of coarse grains; and the consumption of wheat for feed would increase.

Wheat production in general and direct consumption of wheat by the developed importers would not be materially affected by the assumed gain in production in the LDC's. World prices, though lower, would not fall sufficiently to affect internal prices significantly. Wheat consumption in Japan would remain about the same as under set I because the price of rice is expected to fall more than the price of wheat, thus increasing consumption of rice rather than wheat. However, feed wheat consumption in the European regions would be expected to rise as internal prices for feed wheat become relatively more attractive and the cost of subsidizing wheat exports increased. In the EC, export availabilities of wheat would be reduced to 2.4 million tons from the 3.9 million under set I. Imports of coarse grains would be lowered by 0.7 million tons as some of the increased feed wheat replaced coarse grains.

Rice

The higher assumed growth in production for the LDC's would result in decreased rice trade in that area. Normally, the bulk of rice shipments of less developed exporters moves to other LDC's. For example, during 1963-65, over four-fifths of Southeast Asia's rice shipments went to other LDC's, primarily South Asia and Indonesia. But with increased rice output, the demand of LDC importers would be reduced, which would dampen the outlook for a substantial increase in rice exports by LDC exporters. Rice imports in the less developed importing countries are expected to drop from 4.7 million tons under set I to 4.1 million tons under set II. The impact of this decline is even more critical since LDC imports normally make up about three-fourths of world rice trade. Thus, under set II conditions, world trade prices in rice would be lower, but would be kept from falling precipitously by a sizable reduction in exports of the major developed exporters, particularly the United States.

The price change would have a slight influence on production and consumption of developed importers. Output would be expected to drop and consumption would rise, resulting in a 0.3 million-ton increase in their imports. Japan would account for two-thirds of that gain.

Coarse Grains

World trade prices for coarse grains under set II follow the same downtrend as those for wheat and rice. Increased coarse grain production under set II would cause the LDC's to shift from a net import to a net export position. Exporters would still continue to ship coarse grains to those LDC's with developing livestock economies, but LDC import requirements would drop from 16.6 million to 10.7 million tons. LDC exports to Japan and Western Europe would increase substantially above the set I level. With lower trade prices, there would be some increase in import demand by the developed importers, except the EC. Even though total grain consumption would increase in the EC, its imports of coarse grains would fall because of increased use of wheat for feed. The net effect of these production and trade shifts on the developed exporters would be a drop in exports of about 10 million tons from the level under set I, with the United States accounting for the major share of this decline.

Projection Set II-A

This set introduces an assumption to determine what might happen if the major developed grain exporters adopted a policy to maintain their traditional share of the world market. Other set II-A assumptions are the same as in projection set II, which is the base of comparison. The major developed exporters, in retaining their market shares, would substantially increase their grain production and exports, even though grain prices would drop precipitously below set II levels.

Lower price levels would bring more wheat into competition with coarse grains, resulting in a sharp rise in the use of wheat for feed, particularly in the United

Table 20.--Wheat: Production, consumption, and trade, projections to 1980 under projection sets II-A, II-B, and III 1/

Region	1980--proj. set II-A			1980--proj. set II-B			1980--proj. set III		
	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/
	Million metric tons								
Developed:									
Importers--									
EC	34.9	36.6	-1.7	33.0	36.6	-3.7	36.0	31.1	4.9
United Kingdom	4.4	9.5	-5.2	4.2	9.2	-5.1	4.5	8.9	-4.4
Other W. Europe	11.3	11.2	.1	11.0	11.3	-.4	11.2	10.7	.5
Japan	.8	7.7	-6.9	.8	8.1	-7.3	.8	7.3	-6.5
South Africa, Rep. of	1.0	1.9	-.9	1.3	1.8	-.5	1.3	1.8	-.5
Subtotal 3/	52.4	66.9	-14.5	50.1	67.1	-17.0	53.7	59.8	-6.0
Major exporters--									
United States	56.1	30.3	21.8	51.4	26.9	21.5	43.5	20.8	22.6
Canada	27.4	9.4	13.6	24.3	7.4	13.4	19.3	4.0	14.0
Australia and New Zealand	14.0	3.0	8.3	13.1	2.9	8.2	11.4	2.8	8.4
Subtotal 3/	97.4	42.6	43.7	88.8	37.2	43.1	74.2	27.6	44.9
Total, developed 3/	149.8	109.5	29.1	138.9	104.3	26.1	128.0	87.3	38.9
Central plan:									
Eastern Europe	30.6	32.9	-2.4	30.6	32.8	-2.2	30.7	32.5	-1.8
USSR	83.6	80.3	3.2	83.8	80.1	3.7	84.3	79.8	4.6
Communist Asia	35.7	42.3	-6.6	35.8	42.2	-6.4	36.0	42.1	-6.1
Total, central plan	149.9	155.6	-5.7	150.3	155.1	-4.8	151.0	154.3	-3.3
Less developed:									
Importers--									
Cent. Am. & Mexico	3.9	6.4	-2.6	3.9	6.3	-2.4	2.7	5.1	-2.4
East South America	1.3	6.5	-5.2	1.3	6.4	-5.1	1.0	6.0	-4.9
West South America	2.0	5.8	-3.8	2.1	5.8	-3.7	1.8	5.1	-3.3
East Africa	.9	1.7	-.8	.9	1.7	-.8	.7	1.4	-.7
West Africa	4/	1.7	-1.7	4/	1.7	-1.7	4/	1.4	-1.4
North Africa	5.5	15.4	-9.9	5.6	15.4	-9.8	5.1	13.7	-8.6
West Asia	19.9	24.6	-4.7	20.0	24.5	-4.5	16.4	22.0	-5.7
South Asia	59.9	54.0	5.9	59.9	53.4	6.6	35.4	43.5	-8.1
Southeast Asia	.1	.6	-.5	.1	.6	-.4	.1	.5	-.4
East Asia & Pacific Is.	.5	5.2	-4.7	.5	5.1	-4.6	.4	4.4	-4.0
Subtotal 3/	94.1	122.0	-27.9	94.4	120.8	-26.4	63.7	103.3	-39.7
Major exporters--									
Argentina	9.2	4.7	4.5	9.7	4.6	5.1	8.9	4.8	4.1
Total, less developed 3/	103.3	126.8	-23.4	104.2	125.4	-21.2	72.6	108.2	-35.6
World total 3/	403.0	391.8		393.4	384.8		351.6	349.8	

1/ Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in Set I.

2/ Some regions do not balance because of stocks.

3/ May not add because of rounding.

4/ Less than .05 million.

Table 21.--Rice: Production, consumption, and trade, projections to 1980 under projection sets II-A, II-B, and III 1/

Region	1980--proj. set II-A			1980--proj. set II-B			1980--proj. set III		
	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/
	1,000 metric tons								
Developed:									
Importers--									
Canada	--	66	-66	--	66	-66	--	64	-64
EC	446	785	-339	413	806	-393	478	765	-287
United Kingdom	--	140	-140	--	140	-140	--	132	-132
Other W. Europe	505	587	-82	471	585	-114	536	559	-23
Japan	10,903	11,311	-408	10,724	11,224	-500	11,179	11,291	-112
South Africa, Rep. of	5	143	-138	5	142	-137	5	135	-130
Subtotal	11,859	13,032	-1,173	11,613	12,963	-1,350	12,198	12,198	-748
Major exporters--									
United States	3,200	1,299	1,958	3,203	1,298	2,036	3,273	1,284	3,013
Australia & N.Zealand	218	83	135	219	82	137	241	76	165
Subtotal	3,418	1,382	2,093	3,422	1,380	2,173	3,514	1,360	3,178
Total, developed	15,277	14,414	920	15,035	14,343	823	15,712	14,306	2,430
Central plan:									
Eastern Europe	124	504	-380	125	503	-378	128	478	-350
USSR	1,211	1,518	-307	1,212	1,516	-304	1,224	1,481	-257
Communist Asia	88,372	87,811	561	88,382	87,807	575	88,579	87,725	854
Total, central plan	89,707	89,833	-126	89,719	89,826	-107	89,931	89,684	247
Less developed:									
Importers--									
Cent. Am. & Mexico	1,689	2,094	-405	1,683	2,115	-432	1,096	1,669	-573
West South America	1,858	1,782	76	1,857	1,783	74	1,280	1,368	-88
East Africa	1,607	2,149	-542	1,609	2,162	-553	1,301	1,783	-482
West Africa	2,123	2,879	-756	2,125	2,880	-764	1,681	2,563	-882
West Asia	1,847	2,296	-449	1,849	2,315	-466	1,328	1,984	-656
South Asia	80,436	81,377	-941	80,426	81,379	-953	63,838	64,919	-1,081
East Asia & Pac. Is.	34,819	35,801	-982	34,866	35,835	-969	25,492	27,896	-2,404
Subtotal	124,379	128,378	-3,999	124,415	128,478	-4,063	96,016	102,182	-6,166
Major exporters--									
Argentina	298	218	80	299	218	81	217	200	17
East South America	8,515	8,369	146	8,512	8,418	94	6,548	6,630	-82
North Africa	2,781	2,095	686	2,784	2,119	665	1,982	1,586	396
Southeast Asia	26,283	23,991	2,292	26,453	23,943	2,510	23,844	20,687	3,157
Subtotal	37,877	34,673	3,204	38,048	34,698	3,350	32,591	29,103	3,488
Total, less developed	162,256	163,051	-795	162,463	163,176	-713	128,607	131,285	-2,678
World total	267,240	267,298		267,217	267,345		234,250	235,275	

1/ Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in set I.

2/ Some regions do not balance because of stocks.

Table 22.--Coarse grains: Production, consumption, and trade, projections to 1980 under projection sets II-A, II-B, and III 1/

Region	1980--proj. set II-A			1980--proj. set II-B			1980--proj. set III		
	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/
	Million metric tons								
Developed:									
Importers--									
EC	50.1	59.8	-9.7	50.3	62.8	-12.6	50.8	60.7	-9.9
United Kingdom	14.2	19.6	-5.4	13.3	18.3	-5.1	14.6	16.2	-1.6
Other W. Europe	27.7	35.3	-7.6	26.9	36.9	-10.0	28.2	32.7	-4.5
Japan	1.0	20.4	-19.4	1.0	21.5	-20.5	1.0	17.4	-16.4
Subtotal 3/	93.0	135.1	-42.0	91.4	139.6	-48.1	94.6	127.1	-32.4
Major exporters--									
United States	232.2	194.7	33.6	299.8	190.4	36.7	212.9	177.0	35.8
Canada	17.8	15.1	2.5	17.9	16.1	1.8	18.5	17.0	1.6
Australia and New Zealand	5.9	3.6	2.3	6.1	3.6	2.5	6.4	3.5	2.9
South Africa, Rep. of	10.3	7.9	2.5	10.5	7.6	2.9	11.2	6.9	4.2
Subtotal 3/	266.3	221.3	41.0	264.3	217.7	43.8	249.1	204.4	44.6
Total, developed 3/	359.3	356.4	-1.0	355.8	357.3	-4.3	343.7	331.5	12.1
Central plan:									
Eastern Europe	55.1	54.9	.2	55.3	54.7	.5	55.5	54.3	1.2
USSR	77.6	77.4	.2	77.7	77.3	.4	78.0	77.2	.8
Communist Asia	66.4	66.9	-.5	66.4	66.8	-.4	66.5	66.8	-.3
Total, central plan 3/	199.0	199.2	-.1	199.4	198.9	.5	200.0	198.3	1.7
Less developed:									
Importers--									
Cent. Am. & Mexico	21.8	23.0	-1.2	21.9	22.9	-1.0	15.7	18.8	-3.1
West South America	3.3	4.6	-1.3	3.3	4.6	-1.2	3.0	4.3	-1.3
West Africa	15.3	17.7	-2.4	15.3	17.6	-2.3	13.1	16.3	-3.3
North Africa	13.1	13.7	-.6	13.1	13.6	-.5	9.6	11.3	-1.6
West Asia	12.0	15.0	-3.0	12.0	14.8	-2.8	10.3	13.3	-3.0
South Asia	41.3	43.9	-2.6	41.4	43.9	-2.5	33.7	36.9	-3.2
East Asia & Pacific Is.	15.1	17.0	-1.8	15.2	16.8	-1.6	9.9	15.1	-5.2
Subtotal 3/	121.9	134.9	-12.9	122.3	134.2	-11.9	95.4	116.1	-20.8
Major exporters--									
Argentina	14.9	7.1	7.8	15.0	6.9	8.2	12.2	6.2	6.0
East South America	22.8	22.0	.8	23.3	21.4	1.8	17.8	17.8	4/
East Africa	23.5	20.8	2.7	23.6	20.7	3.0	17.6	17.6	4/
Southeast Asia	4.7	2.0	2.7	4.8	2.0	2.8	2.8	1.9	.9
Subtotal 3/	65.9	51.9	14.0	66.8	51.0	15.8	50.4	43.5	6.9
Total, less developed 3/	187.9	186.8	1.1	189.1	185.2	3.9	145.7	159.6	-13.9
World total 3/	746.2	742.4		744.2	741.4		689.4	689.4	

1/ Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in Set I.

2/ Some regions do not balance because of stocks.

3/ May not add because of rounding.

4/ Less than .05 million.

States and Canada. Because of very unfavorable world prices for wheat, the EC would expand use of wheat for feed. Wheat exports of the EC would be sharply reduced and the EC could become a net importer of wheat. Consequently, increased feed use of wheat would limit import growth of coarse grains in the EC. An increase in EC coarse grain imports would also be limited by high internal prices which would not be affected materially by the lower world prices. In contrast, imports of coarse grains would increase significantly in Japan, the United Kingdom, and Other Western Europe as prices in these countries would adjust more to lower world prices than would EC prices. Taken together, coarse grain imports of the developed importing countries would be about a fifth higher under set II-A than under set II.

In South Asia, wheat exports would drop about 20 percent from the 7.1 million tons of set II. Argentine wheat and coarse grain exports, which are particularly sensitive to world prices, would drop substantially as a result of the greatly reduced prices. However, the reduction in wheat exports would be greater because the competitive situation would favor coarse grains—world wheat prices would fall more rapidly than coarse grain prices. Southeast Asia's exports of coarse grains would also decline, but not to the extent as those for Argentina.

Lower prices and greater availability would increase wheat imports in the less developed importing countries by around 3 million tons. A similar situation would occur for coarse grains, with imports increasing 2 million tons above set II level.

For rice trade, set II-A shows that the less developed exporters would lose some exports as the developed exporters pushed to retain market shares. But total import demand for rice would increase in response to lower prices, which mitigates part of the push. This is especially true in the less developed areas, where imports would increase by 1 million tons above set II levels. Thus, rice exports from the less developed areas would drop only to 3.2 million tons from the 3.9 million in set II—even though the increase for developed exporters would be much greater. Most of the reduction in rice exports would occur in Southeast Asia.

Projection Set II-B

Thus far in the sequence, the major developed importers would have continued their policy of relatively high internal prices. The basic assumption change under projection set II-B is that grain prices of the developed importers would become more sensitive to world levels and the high internal prices would be adjusted to changes in world prices. The results of projection set II-B are compared with those of set II-A, since the other assumptions remain the same in both sets.

With lower internal grain prices in the developed importing countries, production would be expected to drop and consumption and imports should increase. However, increases in wheat consumption would be modest. Consumption of wheat in the EC would remain about the same as in set II-A, even though internal market prices would be lower. However, world wheat prices would be higher under set II-B than under II-A, resulting in less pressure to subsidize wheat for feed use because the export subsidy for wheat would be considerably lower. But wheat imports would increase because the lower internal wheat prices would discourage production of wheat in the EC. On balance, the developed importers would increase imports of wheat by 2.5 million tons.

With higher world prices, imports of wheat in the LDC's would decrease from the levels of set II-A. But Argentina would further increase its exports.

Coarse grains consumption would increase substantially in all the developed importing countries, resulting in a 6 million-ton increase of imports over the level of set II-A. About half of the increase would occur in the EC, followed by a substantial increase in Other Western Europe. The less developed exporters would be expected to gain about 2 million tons of the expansion of the coarse grains market in the developed area. The developed exporters would absorb the other two-thirds of the growth. The consumption increase in Japan could very easily be much higher than projected, but it is assumed that some import restrictions will still be in effect even though prices of grain would be reasonable.

The developed area's rice imports would also increase significantly, to 1.4 million tons, with the developed and less developed exporters both benefiting from the expansion.

Projection Set III

What might the situation be if the Green Revolution were short-lived and production growth lapsed to lower rates? Projection set III was designed to answer this question by assuming that the annual growth in production in the LDC's would fall below the growth rate of set I by a factor of 0.7. As a result, growth in income and in demand for grains would also be reduced. Other set III assumptions are the same as in set I, which is comparative base for the following discussion.

Wheat

Because of their unused production capacity, the developed exporters would be able to supply increased LDC import requirements arising from deceleration of

production growth. Thus, world prices would not rise as sharply above set I levels as might be expected. Wheat imports of the less developed importers would increase by 6 million tons over set I levels. The impact of the slower growth rate in production on trade would be mitigated by reduced consumption via the income effect and also directly in the noncommercial or subsistence sector via the supply constraint. Wheat exports of the EC would increase in response to the world price of wheat, which would rise relative to coarse grains. The price impact in set III is greater for wheat than for coarse grains since the LDC's account for a larger portion of world consumption and trade of wheat than coarse grains.

Rice

Under set III, rice production in the LDC's would be 14 million tons lower than the level of set I, but imports would increase by only 1.2 million tons. LDC imports are surprisingly small because: (1) the world rice price rises more than that for wheat and coarse grains during periods of shortfalls in grain production; thus, it would be cheaper for the LDC's to import wheat and coarse grains; and (2) consumption of rice in the LDC's is also reduced. The United States would be expected to increase its exports of rice substantially, while the net import position of the developed importers would vary little.

Communist Asia might possibly ship more rice and import less wheat than projected under set III because of the relatively high rice price under this projection set.

Coarse Grains

Net imports of the less developed area would increase by 8 million tons above the levels indicated in projection set I, but only half of this change is attributed to increased imports; the other half would be due to decreased exports. The production decrease below set I levels would have little effect on the export position of the central plan countries or the developed importers but would result in larger shipments from the developed exporters.

Other Projection Sets

The use of a mathematical projections model for grains permitted several additional projection sets that could not have been feasible otherwise.[41] Some of these sets were used to test the sensitivity of the coefficients in the world grain model. For example, it was found that a 10 million-ton shortfall in rice production in South Asia would result in an increase in rice imports of less than 2 million tons, but in a 6 million-ton increase in wheat imports. That is, substantial changes in grain production levels in South Asia are compensated by changes in wheat trade.

Another set of sensitivity tests determined the export elasticities implied in the model for the major exporters. Specifically, what would happen to U.S. wheat export prices if U.S. exports of wheat increased by some specific amount? A parametric analysis indicated that if U.S. wheat exports were to increase by 1 million tons, the world price of wheat would drop by $1.19 a ton. This would be equivalent to an export demand elasticity of -2.7. Similarly, an increase in U.S. coarse grains exports resulting from larger supplies in exporting countries would reduce the world price by $1.11 per ton, assuming ceteris paribus conditions. This gave an export demand elasticity for coarse grains of -1.7, which is lower than that for wheat. Both of these were obtained from analyses using the assumption of set I—that developed exporters would adjust their supplies to help maintain world prices. Thus, by assumption, Canada and Australia would withdraw from the market rather than have prices fall to unreasonable levels. On the other hand, the price stability assumption applied only to the United States for coarse grains. Thus, the world coarse grains market would be less price responsive on the supply side. The responsiveness on the demand side would also be low under set I because internal prices in the major markets—for example, the EC—tend to be insulated from external pressure. However, if the parametric analysis is applied to the assumptions of set II-A, the export demand elasticity for wheat falls to -0.5. This is not unexpected since under set II-A, the major exporters maintain their share of the world market. As a result, the export demand elasticity for wheat would tend to approach the world demand elasticity for wheat, which is low. Similar parametrics could have been run to determine the export and import demand elasticities for wheat, rice, and coarse grains for the other regions.

The grain production and consumption levels for the LDC's projected by FAO in its Indicative World Plan were also incorporated into the world grain model.[42] The overall FAO report (*55*) did not integrate the

[41] In most instances, model I, as discussed on p. 25, was used because of its substantially lower cost per run compared with the cost of running model II. Model II was used for projection sets I, II, and III. Model I was used in sets II-A and II-B. Model I was also used to obtain preliminary values for sets I, II, and III.

[42] These estimates were taken from the four IWP regional reports (*44*, *50*, *51*, *54*). In FAO's Indicative World Plan, consumption is projected under the assumption of constant prices; then, taking into account the resource base and developmental plans of the country, the amount of consumption coming from domestic production would be determined. The difference between the consumption and production estimates then becomes the exportable surplus or importable deficit.

regional projections into a world frame, but only discussed the kind of adjustments the developed world would have to make for the projected LDC export trade to be realized. The results and trade implications for the IWP trial projections were similar to those obtained and discussed under projection sets II and II-A.

Table 23.--Total grains: Production, consumption, and trade, 1964-66 average, and projections to 1980 under projection sets I and II 1/

Region	1964-66			1980--proj. set I			1980--proj. set II		
	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/
	Million metric tons								
Developed:									
United States	174.6	144.1	44.5	257.0	203.6	51.4	252.9	210.4	36.0
Canada	32.9	17.7	14.5	36.9	21.6	12.9	35.6	22.5	9.0
EC	60.1	71.4	-10.8	87.1	93.6	-6.5	86.9	94.1	-7.2
United Kingdom	13.3	21.3	-7.9	19.0	25.3	-6.3	18.9	26.5	-7.6
Other W. Europe	30.0	36.9	-6.9	39.8	44.4	-4.6	39.6	45.3	-5.7
Japan	14.1	24.1	-10.4	12.9	36.4	-23.4	12.8	36.9	-24.1
Australia & N. Zealand	13.5	5.1	7.1	17.7	6.4	10.8	17.0	6.5	9.6
South Africa, Rep. of	5.9	5.9	4/	12.3	9.0	3.3	12.1	9.2	2.8
Total, developed	344.4	326.4	30.0	482.7	440.4	37.5	475.8	451.4	12.9
Central plan:									
Eastern Europe	64.9	71.3	-6.4	86.3	87.4	-1.1	86.3	87.4	-1.2
USSR	115.0	117.3	-2.4	163.5	158.4	5.1	163.4	158.5	4.9
Communist Asia	133.8	138.5	-4.7	191.0	196.6	-5.6	190.8	196.7	-6.0
Total, central plan	313.7	327.2	-13.5	440.8	442.4	-1.7	440.4	442.7	-2.3
Less developed:									
Cent. Am. & Mexico	13.7	14.4	-.7	22.5	27.5	-5.0	27.8	31.0	-3.1
Argentina	17.0	7.8	10.3	23.5	11.3	12.2	26.0	11.3	14.7
East South America	17.2	19.6	-2.4	28.7	32.4	-3.7	33.8	35.3	-1.6
West South America	5.3	6.6	-1.4	6.6	11.2	-4.7	7.3	11.9	-4.6
East Africa	13.6	14.2	-.6	22.3	22.2	4/	26.4	24.3	2.1
West Africa	12.4	13.4	-1.0	15.9	20.1	-5.1	17.6	22.0	-4.5
North Africa	11.8	15.1	-3.3	18.7	28.1	-9.4	21.6	30.9	-9.3
West Asia	21.7	24.5	-2.8	30.4	38.8	-8.4	34.0	41.3	-7.3
South Asia	89.0	100.8	-11.8	151.4	157.3	-5.9	182.2	177.6	4.6
Southeast Asia	19.7	16.4	3.5	28.9	25.3	3.6	31.7	26.4	5.3
East Asia & Pacific Is	24.6	28.8	-4.1	41.7	51.3	-9.5	50.7	57.5	-6.8
Total, less developed	246.1	261.7	-14.3	390.5	426.3	-35.8	458.8	469.5	-10.5
World total 3/	904.2	915.3	2.3	1,314.0	1,309.2	4/	1,375.0	1,363.6	.2

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in Set I.

2/ Some regions do not balance because of stocks.

3/ May not add because of rounding.

4/ Less than .05 million.

Table 24.--Total grains: Production, consumption, and trade, projections to 1980 under projection sets II-A, II-B, and III 1/

Region	1980-proj. set II-A			1980--proj. set II-B			1980--proj. set III		
	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/	Production	Consumption	Net trade 2/
	Million metric tons								
Developed:									
United States	291.5	226.3	57.4	284.4	218.5	60.2	259.8	199.1	61.4
Canada	45.2	24.6	16.1	42.2	23.6	15.1	37.8	21.0	15.5
EC	85.5	97.2	-11.7	83.6	100.3	-16.6	87.3	92.6	-5.2
United Kingdom	18.6	29.2	-10.7	17.4	27.7	-10.3	19.1	25.3	-6.2
Other W. Europe	39.6	47.2	-7.6	38.3	48.8	-10.5	39.9	43.9	-4.1
Japan	12.7	39.4	-26.7	12.5	40.8	-28.3	13.0	36.0	-23.1
Australia & N. Zealand	20.1	6.7	10.7	19.4	6.6	10.8	18.1	6.3	11.5
South Africa, Rep. of	11.3	9.8	1.4	11.8	9.6	2.2	12.5	8.8	3.6
Total, developed	524.4	480.3	29.1	509.7	475.9	22.6	487.4	433.1	53.5
Central plan:									
Eastern Europe	85.8	88.4	-2.5	86.0	88.0	-2.0	86.3	87.3	-1.0
USSR	162.3	159.2	3.1	162.7	158.9	3.8	163.6	158.4	5.2
Communist Asia	187.5	194.0	-6.5	187.6	193.9	-6.3	191.1	196.6	-5.5
Total, central plan	435.6	441.5	-5.9	436.3	440.8	-4.5	441.0	442.3	-1.3
Less developed:									
Cent. Am. & Mexico	27.4	31.6	-4.2	27.5	31.3	-3.8	19.5	25.6	-6.1
Argentina	24.4	12.0	12.4	25.0	11.7	13.3	21.3	11.2	10.1
East South America	32.7	36.9	-4.2	33.1	36.3	-3.2	25.4	30.4	-5.0
West South America	7.2	12.2	-5.0	7.2	12.1	-4.9	6.1	10.8	-4.7
East Africa	26.0	24.7	1.3	26.2	24.5	1.7	19.6	20.8	-1.2
West Africa	17.5	22.3	-4.8	17.5	22.2	-4.7	14.8	20.3	-5.5
North Africa	21.4	31.2	-9.8	21.5	31.1	-9.6	16.7	26.6	-9.8
West Asia	33.7	41.9	-8.1	33.9	41.6	-7.8	28.0	37.3	-9.3
South Asia	181.6	179.2	2.4	181.8	178.7	3.1	132.9	145.4	-12.4
South East Asia	31.2	26.6	4.6	31.4	26.5	4.9	26.7	23.1	3.6
East Asia & Pacific Is	50.5	58.0	-7.5	50.6	57.8	-7.2	35.8	47.5	-11.7
Total, less developed	453.5	476.6	-23.1	455.7	473.8	-18.1	346.9	399.1	-52.1
World total 3/	1,413.5	1,398.5	4/	1,401.8	1,390.6	4/	1,275.3	1,274.5	4/

1/ Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in set I.

2/ Some regions do not balance because of stocks.

3/ May not add because of rounding.

4/ Less than .05 million.

Table 25.--Wheat: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets I and II 1/

Region	Historical 2/			1980--proj. set I			1980--proj. set II		
	Production	Consumption		Production	Consumption		Production	Consumption	
		Total	Per Capita		Total	Per Capita		Total	Per Capita
	Percent								
Developed:									
Importers--									
EC	2.1	0.8	0.2	1.5	1.0	0.4	1.5	1.3	0.7
United Kingdom	2.0	0.3	-0.4	1.6	0.8	0.1	1.6	0.9	0.2
Other W. Europe	1.4	0.8	3/	0.5	-0.5	-1.2	0.5	-0.5	-1.2
Japan	-4.9	2.3	1.4	-2.3	3.1	2.2	-2.3	3.0	2.1
South Africa, Rep. of	2.6	1.5	-1.0	2.1	3.5	0.9	2.1	3.5	0.9
Subtotal	1.8	0.9	0.3	1.2	0.9	0.2	1.2	1.1	0.3
Major exporters--									
United States	2.2	0.3	-1.1	1.1	1.6	0.2	1.0	2.3	0.9
Canada	2.8	3/	-1.9	0.6	0.2	-1.7	0.3	0.9	-1.0
Australia and New Zealand	4.6	1.5	-0.3	0.4	3/	-1.8	3/	3/	-1.7
Subtotal	2.8	0.3	-1.1	0.8	1.2	-0.2	0.7	1.8	0.5
Total, developed	2.4	0.7	-0.3	1.0	1.1	3/	0.9	1.4	0.3
Central plan:									
Eastern Europe	3.3	3.1	2.2	2.4	1.6	0.7	2.4	1.6	0.7
USSR	2.5	2.8	1.5	2.1	2.1	0.9	2.1	2.1	0.8
Communist Asia	-0.8	1.4	-0.6	3.4	3.1	1.0	3.4	3.1	1.0
Total, central plan	2.1	2.6	0.1	2.4	2.2	0.5	2.4	2.2	0.5
Less developed:									
Importers--									
Cent. Am. & Mexico	3.3	2.9	-0.3	3.9	4.7	1.5	5.5	5.5	2.2
East South America	-6.2	1.9	-1.0	2.1	3.5	0.6	3.0	3.8	0.9
West South America	0.7	2.1	-0.7	1.3	4.7	1.8	2.0	5.1	2.2
East Africa	3.2	3.3	0.9	2.9	4.6	2.2	4.1	5.2	2.8
West Africa	3.2	3.9	1.3	2.8	7.1	4.4	3.9	7.7	5.1
North Africa	0.9	2.9	3/	0.8	4.3	1.3	1.3	4.8	1.8
West Asia	2.3	2.5	-0.2	2.0	3.0	0.3	2.8	3.5	0.7
South Asia	2.8	2.8	0.4	5.4	4.2	1.7	7.6	5.2	2.7
Southeast Asia	6.4	3.3	0.7	4.6	5.7	3.0	6.4	5.9	3.3
East Asia & Pacific Is.	2.3	3.7	0.9	2.1	4.1	1.3	2.9	4.5	1.7
Subtotal	2.2	2.7	0.4	3.7	4.0	1.4	5.4	4.7	2.0
Major exporters--									
Argentina	1.0	0.9	-0.7	2.4	1.3	-0.3	2.8	1.0	-0.6
Total, less developed	2.1	2.6	3/	3.5	3.9	1.2	5.1	4.5	1.8
World total	2.2	2.1	3/	2.1	2.4	0.3	2.5	2.6	0.6

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in set I.

2/ Extrapolations of linear trends from early 1950's to 1968 period.

3/ Less than 0.1 percent.

Table 26.--Rice: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets I and II 1/

Region	Historical 2/			1980--proj. set I			1980--proj. set II		
	Production	Consumption		Production	Consumption		Production	Consumption	
		Total	Per Capita		Total	Per Capita		Total	Per Capita
	Percent								
eveloped:									
Importers--									
Canada	--	2.0	0.3	--	3.2	1.2	--	3.4	1.5
EC	-1.5	0.3	-0.2	-0.4	1.1	0.5	-0.6	1.2	0.7
United Kingdom	--	2.4	1.7	--	1.0	0.3	--	1.3	0.6
Other W. Europe	0.2	1.4	0.7	1.3	0.7	3/	1.0	1.0	0.2
Japan	1.6	-0.4	-1.3	-0.6	-0.3	-1.2	-0.7	-0.3	-1.1
South Africa, Rep. of	4/	3.8	1.2	6.3	5.2	2.6	6.3	5.5	2.9
Subtotal	1.4	-0.2	3/	-0.5	-0.1	-0.1	-0.6	-0.1	-0.9
Major exporters--									
United States	3.3	1.3	0.1	1.5	1.5	3/	1.4	1.5	0.1
Australia and New Zealand	4.1	3.2	1.3	5.1	4.8	3.0	4.7	5.3	3.5
Subtotal	3.3	1.4	0.2	1.7	1.6	0.4	1.6	1.7	0.4
otal, developed	1.8	-0.1	-1.1	3/	3/	-1.0	-0.2	3/	-1.0
entral plan:									
Eastern Europe	-1.7	3.4	2.5	1.4	0.8	3/	1.2	0.9	3/
USSR	5.5	3.2	2.1	8.4	5.6	4.5	8.4	5.7	4.5
Communist Asia	0.6	1.4	-0.6	2.3	2.1	3/	2.2	2.1	3/
otal, central plan	0.6	1.4	-0.3	2.3	2.1	0.3	2.3	2.1	0.3
ess developed:									
Importers--									
Cent. Am. & Mexico	2.2	1.8	-1.3	4.3	4.0	0.8	6.1	5.0	1.7
West South America	3.0	3.2	0.4	3.8	3.4	0.6	5.4	4.5	1.6
East Africa	2.3	2.3	3/	2.4	3.3	0.9	3.3	3.9	1.5
West Africa	2.0	2.6	3/	2.3	2.9	0.2	3.4	3.2	0.6
West Asia	3.4	3.6	0.9	3.4	3.2	0.5	4.8	3.9	1.2
South Asia	2.0	1.9	-0.5	2.5	2.5	0.1	3.4	3.4	1.0
East Asia & Pacific Is.	1.7	1.8	-1.0	3.3	3.0	0.3	4.5	4.1	1.3
Subtotal	2.0	1.9	-0.4	2.8	2.7	0.2	3.8	3.6	1.0
Major exporters--									
Argentina	1.5	1.6	3/	3.8	3.8	2.2	5.1	4.1	2.5
East South America	3.6	3.2	0.3	3.1	3.5	0.6	4.2	4.4	1.5
North Africa	3.2	3.1	0.2	3.7	4.2	1.2	5.0	5.4	2.4
Southeast Asia	2.1	2.8	0.2	2.3	2.5	3/	2.6	2.8	0.3
Subtotal	2.5	2.9	0.2	2.5	2.8	0.1	3.1	3.3	0.6
otal, less developed	2.1	2.1	-0.5	2.7	2.8	0.1	3.6	3.6	0.9
World total	1.6	1.7	-0.3	2.3	2.3	0.3	2.9	2.8	0.8

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in roductivity in the less developed countries. Set II assumes that agricultural productivity and economic rowth in the less developed countries would be higher than projected in set I.
2/ Extrapolations of linear trends from early 1950's to 1967 period.
3/ Less than 0.1 percent.
4/ No production in 1980.

Table 27.--Coarse grains: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets I and II 1/

Region	Historical 2/			1980--proj. set I			1980--proj. set II		
	Production	Consumption		Production	Consumption		Production	Consumption	
		Total	Per Capita		Total	Per Capita		Total	Per Capita
	Percent								
Developed:									
Importers--									
EC	2.2	2.5	1.9	3.0	2.4	1.8	3.0	2.3	1.7
United Kingdom	3.3	2.6	1.9	3.1	1.5	0.8	3.1	1.9	1.2
Other W. Europe	2.3	2.2	1.5	2.3	2.2	1.5	2.2	2.4	1.7
Japan	3/	4.0	3.1	-2.8	6.3	5.3	-2.8	6.5	5.5
Subtotal	2.4	2.6	2.1	2.7	2.6	1.9	2.7	2.7	2.0
Major exporters--									
United States	1.9	1.8	0.3	2.6	2.4	1.1	2.4	2.5	1.2
Canada	1.3	1.5	-0.4	2.0	2.0	4/	1.9	2.1	0.2
Australia and New Zealand	2.9	3.7	1.9	4.7	3.0	1.2	4.6	3.1	1.3
South Africa, Rep. of	3.0	2.6	4/	3.8	2.9	0.4	3.6	3.1	0.6
Subtotal	1.9	1.8	0.3	2.6	2.4	0.9	2.5	2.5	1.0
Total, developed	2.0	2.1	1.0	2.6	2.5	1.5	2.5	2.6	1.6
Central plan:									
Eastern Europe	1.6	1.9	1.0	1.6	1.5	0.6	1.6	1.6	0.7
USSR	1.0	1.2	4/	2.8	2.8	1.6	2.8	2.8	1.6
Communist Asia	0.8	0.7	-1.3	1.5	1.6	-0.5	1.5	1.6	-0.5
Total, central plan	1.1	1.2	-0.5	2.0	2.0	0.3	2.0	2.0	0.3
Less developed:									
Importers--									
Cent. Am. & Mexico	3.6	3.0	-0.2	3.5	4.9	1.6	4.9	5.7	2.4
West South America	2.1	2.1	-0.7	0.9	3.1	0.3	1.3	3.3	0.5
West Africa	1.6	1.8	-0.8	1.5	2.7	0.2	2.2	3.1	0.5
North Africa	0.8	1.4	-1.5	3.1	3.8	0.8	4.2	4.6	1.6
West Asia	0.8	1.5	-1.2	1.6	2.8	0.1	2.2	3.2	0.5
South Asia	1.3	1.5	-0.9	2.0	2.5	4/	2.8	3.2	0.7
East Asia & Pacific Is.	2.7	2.8	0.1	4.5	5.8	3.0	6.2	6.2	3.4
Subtotal	1.8	1.9	-0.7	2.5	3.4	0.8	3.4	4.0	1.4
Major exporters--									
Argentina	2.5	0.8	-0.8	2.5	2.1	0.5	3.3	2.4	0.8
East South America	3.2	2.7	-0.1	3.4	3.6	0.7	4.5	4.2	1.3
East Africa	2.3	2.5	0.1	3.4	2.9	0.5	4.6	3.5	1.1
Southeast Asia	5.5	5/	5/	6.2	5/	5/	8.5	5/	5/
Subtotal	2.8	2.3	-0.1	3.3	3.3	0.7	4.5	3.8	1.3
Total, less developed	2.1	2.0	-0.6	2.7	3.4	0.8	3.8	4.0	1.3
World total	1.8	1.8	-0.2	2.5	2.5	0.5	2.7	2.7	0.7

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in set I.
2/ Extrapolations of linear trends from early 1950's to 1967 period.
3/ No production in 1980.
4/ Less than 0.1 percent.
5/ Computed percent not relevant because of very small quantity in base period.

Table 28.--Wheat: Annual growth rates for production and consumption, 1964-66 through 1980, under projection sets II-A, II-B, and III 1/

Region	1980--proj. set II-A			1980--proj. set II-B			1980--proj. set III		
	Produc-tion	Consumption		Produc-tion	Consumption		Produc-tion	Consumption	
		Total	Per Capita		Total	Per Capita		Total	Per Capita
	Percent								
eveloped:									
Importers--									
EC	1.3	1.9	1.3	0.9	1.9	1.3	1.5	0.8	0.2
United Kingdom	1.5	1.2	0.5	1.2	1.0	0.3	1.6	0.8	2/
Other W. Europe	0.6	-0.2	-0.9	0.5	-0.1	-0.8	0.5	-0.5	-1.2
Japan	-2.4	3.4	2.5	-2.7	3.8	2.9	-2.3	3.1	2.2
South Africa, Rep. of	0.1	3.8	1.2	0.2	3.7	1.1	2.0	3.5	0.9
Subtotal	1.0	1.6	0.8	0.7	1.6	0.9	1.2	0.9	0.1
Major exporters--									
United States	2.8	3.7	2.2	2.2	2.8	1.4	1.2	1.1	-0.3
Canada	3.3	5.6	3.6	2.4	3.9	2.0	0.9	-0.3	-2.2
Australia and New Zealand	2.0	0.3	-1.4	1.6	0.2	-1.5	0.6	-0.1	-1.8
Subtotal	2.8	3.7	2.3	2.2	2.8	1.4	1.0	0.7	-0.6
otal, developed	2.1	2.4	1.3	1.6	2.0	1.0	1.1	0.8	-0.2
entral plan:									
Eastern Europe	2.3	1.7	0.8	2.4	1.7	0.8	2.4	1.6	0.7
USSR	2.0	2.2	0.9	2.1	2.1	0.9	2.1	2.1	0.9
Communist Asia	3.4	3.1	1.0	3.4	3.1	1.0	3.4	3.1	1.0
otal, central plan	2.4	2.3	0.5	2.4	2.3	0.5	2.4	2.2	0.5
ess developed:									
Importers--									
Cent. Am. & Mexico	5.2	5.9	2.6	5.4	5.7	2.4	2.8	4.3	1.0
East South America	3.0	3.9	1.1	3.0	3.9	1.0	1.5	3.4	0.5
West South America	1.8	5.3	2.5	1.9	5.3	2.4	1.0	4.4	1.6
East Africa	4.0	1.5	3.1	4.1	1.3	3.0	2.1	4.2	1.8
West Africa	3.8	8.0	5.3	3.8	7.9	5.2	1.9	6.6	4.0
North Africa	1.1	4.9	1.9	1.2	4.9	1.9	0.6	4.1	1.1
West Asia	2.7	3.5	0.8	2.8	3.5	0.8	1.4	2.8	2/
South Asia	7.6	5.3	2.8	7.6	5.3	2.8	3.9	3.8	1.4
Southeast Asia	6.3	6.5	3.7	6.3	6.3	3.6	3.3	5.6	2.8
East Asia & Pacific Is.	2.8	4.9	2.1	2.8	4.7	1.9	1.5	3.8	1.0
Subtotal	5.4	4.8	2.2	5.4	4.8	2.1	2.7	3.7	1.0
Major exporters--									
Argentina	1.9	1.4	-0.2	2.3	1.3	-0.3	1.7	1.5	2/
otal, less developed	5.0	4.7	2.0	5.0	4.6	1.9	2.5	3.6	0.9
World total	2.9	3.0	0.9	2.7	2.9	0.8	1.9	2.2	0.2

1/ Set II-A assumes that major developed exporters would maintain their traditional share of the orld market. Set II-B assumes that the major developed importers would become more sensitive to orld grain prices and adjust their high internal prices to changes in world prices. Set III assumes hat agricultural productivity and economic growth in the less developed countries would be lower than rojected in set I.

2/ No production in 1980.

Table 29.--Rice: Annual growth rates of production and consumption, 1964-66 through 1980, under projection sets II-A, II-B, and III 1/

Region	1980--proj. set II-A			1980--proj. set II-B			1980--proj. set III		
	Produc-tion	Consumption		Produc-tion	Consumption		Produc-tion	Consumption	
		Total	Per Capita		Total	Per Capita		Total	Per Capita
	Percent								
Developed:									
Importers--									
Canada	2/	3.4	1.5	2/	3.4	1.5	2/	3.2	1.2
EC	-0.7	1.2	0.7	-1.2	1.4	0.9	-0.2	1.0	0.4
United Kingdom	2/	1.3	0.6	2/	1.3	0.6	2/	0.9	0.3
Other W. Europe	1.0	1.0	0.2	0.5	1.0	0.2	1.4	0.7	-0.1
Japan	-0.7	-0.3	-1.2	-0.8	-0.4	-1.2	-0.5	-0.3	-1.2
South Africa, Rep. of	6.3	5.5	2.9	6.3	5.5	2.9	6.3	5.1	2.5
Subtotal	-0.7	-0.1	-0.9	-0.8	-0.1	-1.0	-0.4	-0.2	-1.0
Major exporters--									
United States	1.4	1.5	0.1	1.4	1.5	0.1	1.6	1.4	2/
Australia and New Zealand	4.5	5.3	3.6	4.6	5.3	3.5	5.2	4.7	3.0
Subtotal	1.6	1.7	0.5	1.6	1.7	0.4	1.8	1.5	0.3
Total, developed	-0.2	3/	-1.0	-0.3	3/	-1.0	3/	3/	-1.0
Central plan:									
Eastern Europe	1.2	1.1	0.2	1.2	1.1	0.2	1.4	0.8	-0.2
USSR	8.4	5.8	4.6	8.4	4.8	4.6	8.5	5.6	4.3
Communist Asia	2.2	2.1	3/	2.2	2.1	3/	2.3	2.1	3/
Total, central plan	2.3	2.1	0.4	2.3	2.1	0.4	2.3	2.1	0.3
Less developed:									
Importers--									
Cent. Am. & Mexico	6.1	5.0	1.8	6.0	5.1	1.8	3.1	3.5	0.3
West South America	5.4	4.6	1.7	5.4	4.6	1.7	2.8	2.7	3/
East Africa	3.1	4.1	1.7	3.1	4.2	1.7	1.7	2.8	0.4
West Africa	3.3	3.4	0.8	3.3	3.5	0.8	1.7	2.6	3/
West Asia	4.8	3.8	1.1	4.8	3.9	1.2	2.5	2.8	0.1
South Asia	3.4	3.4	1.0	3.4	3.4	1.0	1.8	1.9	-0.5
East Asia & Pacific Is.	4.5	4.1	1.3	4.5	4.1	1.3	2.4	2.3	-0.4
Subtotal	3.8	3.7	1.1	3.8	3.7	1.1	2.0	2.1	-0.5
Major exporters--									
Argentina	5.0	4.4	2.5	5.0	4.1	2.5	2.8	3.5	1.9
East South America	4.0	4.5	1.6	4.0	4.5	1.6	2.2	2.8	3/
North Africa	5.0	5.3	2.3	5.0	5.4	2.4	2.6	3.4	0.5
Southeast Asia	2.5	2.8	0.3	2.6	2.8	0.3	1.9	1.8	-0.7
Subtotal	3.0	3.3	0.6	3.0	3.3	0.6	2.0	2.1	-0.6
Total, less developed	3.6	3.6	1.0	3.6	3.6	1.0	2.0	2.1	-0.5
World total	2.8	2.8	0.8	2.8	2.8	0.8	1.9	2.0	3/

1/ Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in set I.

2/ No production in 1980.

3/ Less than 0.1 percent.

Table 30.--Coarse grains: Annual growth rates of production and consumption, 1964-66 through 1980, under projection sets II-A, II-B, and III 1/

Region	1980--proj. set II-A			1980--proj. set II-B			1980--proj. set III		
	Produc-tion	Consumption		Produc-tion	Consumption		Produc-tion	Consumption	
		Total	Per Capita		Total	Per Capita		Total	Per Capita
	Percent								
Developed:									
Importers--									
EC	2.8	2.7	2.0	2.9	2.9	2.2	3.0	2.4	1.8
United Kingdom	3.0	2.8	2.0	2.5	2.3	1.6	3.2	1.5	0.8
Other W. Europe	2.2	2.6	1.9	2.0	3.0	2.2	2.3	2.1	1.4
Japan	-2.8	7.2	6.3	-2.5	7.6	6.7	-2.8	6.1	5.2
Subtotal	2.6	3.2	2.5	2.4	3.3	2.6	2.7	2.6	1.9
Major exporters--									
United States	3.2	3.3	2.0	3.2	3.0	1.7	2.6	2.2	1.0
Canada	2.0	3.3	1.4	2.0	3.0	1.0	2.0	1.8	2/
Australia and New Zealand	4.3	3.2	1.5	4.4	3.2	1.4	4.8	3.0	1.2
South Africa, Rep. of	3.3	3.6	1.1	3.5	3.4	0.8	3.9	2.7	0.2
Subtotal	3.2	3.3	1.8	3.1	3.0	1.5	2.7	2.2	0.8
Total, developed	3.0	3.2	2.2	2.9	3.1	2.1	2.7	2.4	1.4
Central plan:									
Eastern Europe	1.5	1.6	0.7	1.5	1.6	0.7	1.6	1.5	0.7
USSR	2.8	2.8	1.6	2.8	2.8	1.6	2.8	2.8	1.6
Communist Asia	1.5	1.6	-0.4	1.5	1.6	-0.4	1.5	1.5	-0.4
Total, central plan	2.0	2.0	0.3	2.0	2.0	0.3	2.0	2.0	0.2
Less developed:									
Importers--									
Cent. Am. & Mexico	4.8	5.8	2.5	4.8	5.8	2.5	2.5	4.4	1.2
West South America	1.2	3.4	0.6	1.2	3.4	0.5	0.6	3.0	0.2
West Africa	2.2	3.1	0.5	2.2	3.1	0.5	1.1	2.5	3/
North Africa	4.2	4.7	1.7	4.2	4.7	1.7	2.1	3.3	0.4
West Asia	2.1	3.4	0.7	2.1	3.3	0.6	1.1	2.6	-0.1
South Asia	2.8	3.2	0.8	2.8	3.2	0.7	1.4	2.0	-0.4
East Asia & Pacific Is.	6.1	6.4	3.5	6.1	6.3	3.4	3.1	5.5	2.7
Subtotal	3.4	4.1	1.4	3.4	4.1	2.4	1.7	3.1	0.4
Major exporters--									
Argentina	3.2	2.8	1.2	3.3	2.6	1.0	1.9	1.9	0.3
East South America	4.2	4.6	1.7	4.4	4.4	1.5	2.5	3.1	0.2
East Africa	4.5	3.6	1.2	4.5	3.5	1.1	2.5	2.4	0.0
Southeast Asia	8.4	3/	3/	8.4	3/	3/	4.6	3/	3/
Subtotal	4.3	4.1	1.5	4.4	4.0	1.4	2.5	2.9	0.3
Total, less developed	3.7	4.1	1.5	3.7	4.0	1.4	1.9	3.0	0.4
World total	2.9	3.1	1.1	2.9	3.0	1.0	2.3	2.4	0.4

1/ Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in set I.

2/ Less than 0.1 percent.

3/ Computed percentage not relevant because of very small consumption in base period.

Table 31.--Wheat: Export earnings and import costs, 1964-66 average, and alternative projections to 1980 1/

Region	1964-66 2/		Proj. set I		Proj. set II		Proj. set III		Proj. set II-A		Proj. set II-B	
	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value
	Million dollars											
Developed:												
United States		1,345.3		1,119.1		812.3		1,508.6		485.2		809.9
Canada		937.5		782.2		508.4		989.6		319.0		534.5
EC		83.2		245.7		136.8		335.9	39.3		142.0	
United Kingdom	317.9		300.9		274.0		318.4		165.3		240.8	
Other W. Europe	96.0			43.5		51.6		56.9	6.5		17.8	
Japan	264.5		463.0		413.0		459.9		214.8		341.3	
Australia & New Zealand		368.9		462.2		349.3		532.2		169.3		281.3
South Africa, Rep. of	24.3		54.5		48.3		58.9		14.7		21.9	1,625.7
Subtotal	702.7	2,734.9	818.4	2,662.7	735.3	1,858.4	873.2	3,423.2	440.6	973.5	763.8	
Central plan:												
Eastern Europe	397.2		122.9		111.2		131.2		66.9		94.3	
USSR	151.7			306.6		274.9		330.1		70.2		138.6
Communist Asia	437.2		443.5		392.9		471.7		230.4		322.7	
Subtotal	986.1		566.4	306.6	504.1	274.9	602.9	330.1	297.3	70.2	417.0	138.6
Less developed:												
Cent. Am. & Mexico	73.7		151.5		124.8		171.0		73.8		104.0	
Argentina		293.7		316.6		333.7		268.2		74.8		161.1
East South America	220.3		342.5		313.1		368.0		164.4		241.8	
West South America	90.4		237.7		220.9		247.1		123.6		177.5	
East Africa	20.8		50.4		44.9		54.1		24.1		34.5	
West Africa	57.9		104.9		103.5		105.6		57.0		81.1	
North Africa	262.5		625.6		605.3		643.2		319.6		465.8	
West Asia	141.4		363.2		274.8		439.0		155.8		218.6	
South Asia	710.1		173.0			400.7	632.5			204.8		328.5
Southeast Asia	15.0		31.0		26.0		33.8		16.7		23.0	
East Asia & Pac. Is	159.8		300.2		274.2		308.8		168.0		233.8	
Subtotal	1,751.9	293.7	2,380.0	316.6	1,987.5	734.4	3,003.1	268.2	1,103.0	279.6	1,580.1	489.6
World total	3,440.7	3,028.6	3,764.8	3,285.9	3,226.9	2,867.7	4,479.2	4,021.5	1,840.9	1,323.3	2,760.9	2,253.9

1/ Earnings or costs are on a net basis; therefore values are lower than actual levels. Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in set I. Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in set I.

2/ Import costs and export values calculated using net flows and standardized unit values to permit comparison with projected values in 1980.

IX.—IMPLICATIONS FOR TRADE OF LESS DEVELOPED COUNTRIES

Prospects for export earnings or import costs of the LDC's differ materially among the several sets of projections (tables 31-33). As discussed below, some of the prospects can be summed up in general terms, common to all sets, while others are specific to the particular set or individual grain.

A striking overall implication at the world level is that the capacity to produce grain is expected to exceed world demand in 1980 at the relatively high price levels that prevailed during the 1964-66 base period. Thus, prices of grain are likely to decline unless major suppliers adjust production. This conclusion assumes continuation of present food and fiber policies. Also precluded is any major departure in consumption patterns.

Explicit (or implicit) in the demand projections is the continuation of low demand-price elasticities for grain, particularly wheat and rice, at the world and country level. In other words, as in the past, 1980 consumption would not be highly responsive to price changes. As a result, downward pressure on world prices would continue with resulting slow growth in the aggregate value (demand) because increased quantities would be consumed at lower prices to absorb excess supplies. Thus, maintenance of current market shares by all exporters would reduce export earnings.

Consequently, an increase in LDC grain production and exports may not result in an increase in LDC export earnings. If the LDC contribution to trade is small relative to the total quantity traded in the world, an increase in export earnings might be realized. For example, an increase in coarse grain exports from Southeast Asia (Thailand) at the same time other exporters only maintained their levels, could increase export earnings because the impact on world price levels might be small.

However, if the LDC contribution to trade is large, the inelasticity of demand at the world level would predominate and probably decrease LDC export earnings. This situation would prevail especially for rice, which is produced largely in the LDC's. World prices for rice are very sensitive to export levels in Southeast Asia. Furthermore, continued trade constraints by developed importers would further reduce the chances of increased LDC export earnings.

Because the major world suppliers of grains are the developed exporters, their export policies can drastically affect the export earnings situation for the LDC's. For example, a policy by the major exporters to maintain a specific share of the market (as in set II-A) would be likely to lead to a reduction in LDC export earnings. On the other hand, if major developed exporters pursued a policy to maintain relatively stable world prices, LDC export earnings would increase. For example, if the major developed exporters withdrew exportable supplies from the world market (as in set II), the price effect of increased LDC grain production and exports would be moderated. For wheat, historical evidence shows that when major exporters have withheld supplies from the world market by expanding storage programs and limiting production, sharp price declines have been avoided. Thus, a possible strategy for LDC's to follow might be to increase exports to the point that major developed exporters might find it expedient to accommodate, possibly through some cooperative international effort. Expanding grain exports beyond that point may stimulate the developed exporters to adopt policies represented in projection set II-A, with adverse effects on LDC export earnings.

Much of the increase in grain production in the LDC's would be absorbed by an increase in domestic consumption. Once the basic caloric needs are met, further increases in grain production due to the Green Revolution would most likely encourage growth in the livestock industry, particularly if world supplies of grain remained ample. Thus, per capita nutritional levels of the LDC's may be expected to improve.

In some LDC areas, not well suited for production of certain grains (wheat, for example), import demand may increase rapidly. The LDC's could account for an increasing share of world agricultural imports. Some of the increased imports of grain for food and grain for feed would be contingent on concessional sales.

Benefits to LDC's from removal of import restrictions and freer trade may be minimal if developed exporters share in the resulting trade increases—unless special trade arrangements are made in favor of the LDC's. Since the developed exporters have the largest share of the grain market, with current market shares they would gain relatively more from an expanded import market than the LDC exporters.

Accelerating production in the face of falling export earnings could lead to conflict or inconsistency of

Table 32.--Rice: Export earnings and import costs, 1964-66 average, and alternative projections to 1980 1/

Region	1964-66 2/		Proj. set I		Proj. set II		Proj. set III		Proj. set II-A		Proj. set II-B	
	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value
	Million dollars											
Developed:												
United States		225.2		262.1		11.4		443.8		130.5		142.8
Canada	7.1		7.8		5.2		9.1		5.1		5.4	
EC	30.7		37.0		26.1		40.9		24.8		30.1	
United Kingdom	17.0		17.0		10.7		19.4		10.5		11.0	
Other W. Europe	4.6		5.0		6.3		3.3		6.3		9.2	
Japan	116.4		21.2		26.4		16.3		30.3		38.9	
Australia & New Zealand		10.0		19.0		10.3		23.3		8.1		8.7
South Africa, Rep. of	11.5		16.6		10.5		19.2		10.5		10.9	
Subtotal	187.3	235.2	104.6	281.1	85.2	21.7	108.2	467.1	87.5	138.6	105.5	151.5
Central plan:												
Eastern Europe	46.5		44.9		28.7		51.5		30.2		31.4	
USSR	39.7		33.2		22.0		37.2		24.5		25.4	
Communist Asia		135.1		92.2		41.3		120.8		38.6		41.5
Subtotal	86.2	135.1	78.1	92.2	50.7	41.3	88.7	120.8	54.7	38.6	56.8	41.5
Less developed:												
Cent. Am. & Mexico	59.0		61.8		31.0		81.9		32.4		36.1	
Argentina		4.3		5.1		6.0		2.4		5.5		5.8
East South America		57.0		18.9		28.2	12.0			10.0		6.7
West South America	11.3		2.8			7.8	12.9			5.9		6.0
East Africa	27.7		58.6		33.6		72.6		41.1		43.8	
West Africa	69.1		101.5		49.4		131.0		61.0		64.3	
North Africa		51.8		64.7		50.4		55.5		48.8		49.6
West Asia	55.4		74.2		35.6		97.8		34.0		36.9	
South Asia	174.9		98.9		8.8		162.0		68.6		72.9	
Southeast Asia		350.9		302.2		201.4		452.0		147.1		169.9
East Asia & Pac. Is	260.3		205.4		75.9		354.9		68.5		71.0	
Subtotal	657.7	464.0	603.2	390.9	234.3	293.8	925.1	509.9	305.6	217.3	325.0	238.0
World total	931.2	834.3	785.9	764.2	370.2	356.8	1,122.0	1,097.8	447.8	394.5	487.3	431.0

1/ Earnings or costs are on a net basis; therefore values are lower than actual levels. Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in set I. Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in set I.

2/ Import costs and export values calculated using net flows and standardized unit values to permit comparison with projected values in 1980.

assumptions. For example, lower export earnings would discourage economic growth. This is contrary to the assumption made under projection set II, where both production and economic growth are assumed to increase.

LDC's may find it difficult to achieve a consensus on trade policy, since the less developed area includes both importers and exporters. Lower world prices benefiting importers would adversely affect exporters, and higher world prices benefiting exporters would adversely affect importers.

Projection Set I

As mentioned earlier, the basic assumptions underlying projection set I are: (1) continuation of present food and fiber policies, and (2) maintenance of reasonable world prices through supply adjustments on the part of developed exporters.

Wheat

With world prices close to base period values but above prices in the late 1960's, LDC (Argentina) earnings in 1980 from wheat exports would show a slight gain from the base period (table 31 and app. table A-2). The central plan countries would show a large gain, mostly reflecting the shift of the USSR from importer to exporter. In contrast, the major developed exporters would lose somewhat because they would curb production to maintain world base period prices. Within this group, the losses are significant for the United States and Canada, while gains are projected for the EC and Australia.

Import costs to the less developed area for wheat would increase substantially because the demand for wheat in many of the nonproducing countries is expected to expand rapidly.[43] Maintenance of the expanded consumption level would imply continued concessional export transactions and some form of aid, especially to those regions where present and foreseeable wheat technology precludes increased wheat production. In contrast with import costs to other LDC importers, costs for wheat in South Asia (India and Pakistan) are projected to decline substantially, reflecting the substantial increases in wheat production projected for this region.

[43] Import costs of concessional export sales are priced at market value. The true import cost might be considerably lower depending on the "hardness" of terms. For example, the cost of imported wheat under a 40-year P.L. 480 loan for local currency discounted to present-day values is low compared with an ordinary commercial transaction.

Rice

Under set I, world trade prices for rice in 1980 are expected to drop close to a fifth below the relatively high prices of the base period (app. table A-3).[44] Value of world trade in rice would follow a similar pattern as prospects for expanding total world rice trade are not encouraging (table 32). This situation would stem primarily from lack of growth in import markets rather than from lack of capacity of exporters to produce. A projected substantial drop in Japan's import requirements would more than offset the growing import demand in other developed countries. In addition, any possible rise in imports from growth in domestic demand in the less developed area would be limited by the combined effects of inadequate foreign exchange and rising domestic production. Consequently, rice import costs of the LDC importers, as a whole, are projected to be down about 8 percent by 1980. Contributing to this drop are South Asia and East Asia, the two areas where new rice varieties are expected to have the greatest impact on production. Import costs for rice are projected to grow in the other importing less developed countries as growth in demand is expected to be greater than the fall in world prices of rice. However, any substantial increase in value of imports by the LDC's would necessarily have to be concessional trade on the part of developed exporters.

With these import demand prospects, rice exports of Southeast Asia are projected to be only about the same as in the base period, though substantially above the levels in the late 1960's. But projected export earnings for the LDC's would be down compared with those in the base period, since prices are expected to be lower. However, such earnings would be above the level of the late 1960's. Although 1980 export earnings in the developed world would be substantially above those in the base period, there would be little change from the value of exports in the late 1960's. A recovery in Southeast Asia faster than that projected would probably result in a drop in exports of the developed area, mainly from the United States.

Coarse Grains

Under set I, value of world trade in coarse grains would grow substantially during the 1970's—at an annual rate of 3.5 percent (table 33). The growth in import demand is centered in Japan and, surprisingly, in the less developed area. In contrast, import demand for coarse grains in Western Europe, the other large importing complex, is projected to fall as continued high

[44] Scarcity of export availabilities of rice, particularly from the "rice bowl" in relation to import demand during 1966-68 caused both absolute and relative prices to rise considerably.

Table 33.--Coarse grains: Export earnings and import costs, 1964-66 average, and alternative projections to 1980 1/

Region	1964-66 2/		Proj. set I		Proj. set II		Proj. set III		Proj. set II-A		Proj. set II-B	
	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value
	Million dollars											
Developed:												
United States		1,225.4		1,658.4		966.7		2,206.2		795.2		1,264.6
Canada		38.7		92.0		44.7		134.2		62.4		62.1
EC	744.2		632.8		495.4		688.8		291.4		515.1	
United Kingdom	226.1		104.8		151.1		108.6		173.3		219.1	
Other W. Europe	366.8		318.4		313.7		312.7		252.3		441.9	
Japan	401.4		1,074.8		945.4		1,155.7		658.3		917.4	
Australia & New Zealand		37.9		166.4		126.8		195.2		48.6		78.4
South Africa, Rep. of		25.5		224.5		158.8		275.7		55.5		97.2
Subtotal	1,738.5	1,327.5	2,130.8	2,141.3	1,905.6	1,297.0	2,265.8	2,811.3	1,375.3	961.7	2,093.5	1,502.3
Central plan:												
Eastern Europe	25.7			62.1		46.8		75.6		7.2		24.0
USSR		18.7		43.0		26.8		52.7		5.2		14.0
Communist Asia		6.6	19.7		20.6		18.4		18.1		20.2	
Subtotal	25.7	25.3	19.7	105.1	20.6	73.6	18.4	128.3	18.1	12.7	20.2	38.0
Less developed:												
Cent. Am. & Mexico		41.4	131.9		32.8		205.9		37.4		39.5	
Argentina		273.2		380.1		359.0		375.7		156.9		253.7
East South America		12.1		56.6		128.9		0.8		15.2		53.6
West South America	5.6		74.9		57.8		90.4		40.0		51.4	
East Africa	6.3			71.5		152.2		0.2		62.6		101.8
West Africa		4.0	179.0		114.7		231.6		76.7		99.4	
North Africa	6.4		58.1		18.8		109.9		20.0		22.2	
West Asia	30.9		183.8		136.1		218.3		103.7		127.8	
South Asia	90.5		184.2		131.9	139.2	235.7		95.2		119.1	
Southeast Asia		72.3		97.1				59.8		68.6		100.8
East Asia & Pac. Is	21.9		245.0		69.6		384.7		61.8		71.5	
Subtotal	161.6	403.0	1,056.9	605.3	561.7	779.3	1,476.5	436.5	434.8	303.3	530.9	509.9
World total	1,925.8	1,755.8	3,207.4	2,851.7	2,487.9	2,149.9	3,760.7	3,376.1	1,828.2	1,277.7	2,644.6	2,050.2

1/ Earnings or costs are on a net basis; therefore values are lower than actual levels. Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in set I. Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in set I.

2/ Import costs and export values calculated using net flows and standardized unit values to permit comparison with projected values in 1980.

internal prices encourage production growth and limit demand expansion of meat. World trade prices are expected to remain close to the 1964-66 average and a little above prices in the late 1960's (app. table A-4).

Coarse grains export earnings of the LDC's are expected to increase sharply, though the order of magnitude is much smaller than that for imports. The increased exports are consistent with Japan's plans to further diversify its sources of coarse grains supplies by importing from countries which, in turn, would provide a market for Japanese goods.

The large projected gain in import demand in the LDC's presupposes a developing commercial livestock industry likely to be concentrated around large urban centers. This import development would probably take place in large degree only if coarse grain prices are reasonable and if concessional terms of trade and other special trading arrangements are available. And it is doubtful that less developed exporters could provide such terms.

Less developed exporters, excluding Argentina, would be at a disadvantage in European markets because the distribution system there is geared to handling large grain carriers, which cannot be loaded effectively in ports of the less developed exporters.

Projection Set II

Projection set II was designed to measure the impact on export earnings (or import costs) of a 1.4-percent increase in the annual growth in production in the LDC's over the growth rate in projection set I. Growth in income was assumed to increase proportionately.

Wheat

The impact of an accelerated Green Revolution would be most pronounced in two major wheat-producing regions in the less developed area—Argentina and South Asia. Conditions under projection set II would lead to a more favorable trade balance for the LDC's. They would still be net importers, but import costs would drop about one-eighth and export earnings would more than double. Argentina, a traditional exporter, would increase its share of the world market, but the dramatic change would be the shift of South Asia from a net importer to an exporter of 7 million tons of wheat. However, several important developments would be necessary for this shift to occur:

(1) Wheat produced in South Asia (mainly India and Pakistan) would have to be of a quality acceptable in international trade. For the most part, this region produces soft wheat of a quality not suited to present baking technology.

(2) Substantial export subsidies would be needed for South Asia to sell wheat at international price levels, because South Asia's producer prices would be relatively high compared with the world trade price. This subsidy cost could be between $300 million and $400 million.

(3) Traditional exporters (the United States, Canada, and Australia), no matter how reluctant, would back off from their "share" of the market, which would imply a loss of export earnings of close to a billion dollars.

Rice

Import costs of the LDC's for rice would be down substantially from the levels of projection set I, following the pattern of the other grains. But export earnings of the LDC's for rice under set II would also be down, a development which differs from the pattern for the other grains. Since most LDC rice exports are shipped to other LDC's, lower import demand would result in lower export earnings.

Because of unfilled caloric needs and a traditional preference for rice in the importing LDC's, a considerable amount of their increased production under set II would result in increased consumption and a lower import demand. Even though imports would be reduced considerably, the fact that these countries would be able to absorb larger supplies domestically moderates the impact their increased production would have on world trade. But the less developed rice exporters would have to seek other markets for their expanded export availabilities. Consequently, developed exporters (mainly the United States) would have to reduce their share of the world market considerably for world rice prices to be maintained at reasonable levels. Further downward pressures on prices would occur because of the foreign aid constraint on import demand in the LDC's.

Coarse Grains

LDC export earnings from coarse grains would increase about a third and import costs would be reduced by about half from the levels of projection set I. These gains would be possible since the United States, under the assumptions of projection set II, would attempt to maintain world price levels by reducing its exports as LDC's increase theirs.

Most of the gains to the LDC's would come from their increasing share of the larger developed market. Developed exporters would continue supplying a large portion of import needs in the LDC's, which probably implies concessional terms of trade. With lower prices, import costs to the developed world would be reduced

somewhat, though the volume of import trade would increase. On a net basis, value of world trade would drop about a fourth, but only a tenth in volume.

Projection Set II-A

Results of projections under this alternative clearly show that if the developed exporters adjusted their production and trade policies to maintain their traditional share of the world market, they would greatly influence the level of export earnings and import costs of the LDC's. This is even more pronounced when developed exporters like the United States and Canada have a reserve area that can be expanded as well as reduced to meet production objectives without basically changing price policy. A further consideration is that these countries may even have a comparative advantage in the true sense, even though they may have export subsidies and keep domestic prices above the world level. In that case, production with reduced price levels might be higher than when production is controlled. Under projection set II-A, it is implied that in developed exporting countries, domestic prices would drop somewhat to increase domestic consumption—for example, feed use of wheat. However, an export subsidy would be available so that domestic prices, particularly prices to producers, would not fall as drastically as world prices.

Maintenance of world market shares by developed exporters as the Green Revolution accelerates in the less developed area could lead to precipitous price declines because of the relatively inelastic demand for grain imports at the world level.[45] While the quantity trade flow of the less developed exporters may be as large or larger than that under projection set I, the lower prices could cause a substantial drop in export earnings. However, prices might not drop as much as projected since the elasticities used in the projections model may be too low for these lower levels. However, there are no statistical observations at such price levels from which to base other estimates. In addition, to hold their share of the market, it is likely that the developed exporters would make nonprice trade concessions, thereby mitigating the downward adjustment or de-escalation of prices. The critical implication here is that prices would drop considerably as a result of production increases in both the less developed world and the developed countries and also as a result of policies among developed exporters to maintain a fixed share of th market.

But lower prices may be an advantage to the LDC's i terms of savings on imports. This important implicatio may be partly masked by the emphasis given to th export earnings of the LDC's in this report. On balanc a savings of $100 million on imports is equivalent t earnings of $100 million on exports. And the lowe prices under projection set II-A would bring abou import savings that could result in a more favorabl trade balance for the LDC's than that under the othe projection alternatives.

Projection Set II-B

In projection set II-B, there is freer trade i developed markets since it is assumed that develope importers become more sensitive to world prices. As result, high internal prices would be lowered to be mor in line with world prices.

Freer access to developed markets would result i increased import demand for grains. Assuming thi increase were shared by developed and LDC exporters LDC grain export earnings would increase from $80 million in projection set II-A to $1,251 million in se II-B. This projected increase could be conservative as i was assumed under II-B that there would not be an changes in the supply-demand relationships. Thus, thes gains in the export earnings by both the developed and less developed exporters may be looked upon as a minimum. A shift to lower internal prices for grain ir the importing countries could generate pronounced changes in the food policies and strategies of the developed countries. For example, should Japan move toward a "Western food strategy" as defined by Barse (*9*), Japan's imports of grains would greatly exceed the amounts projected in set II-B. As indicated on page 15 of this report, Barse projected imports of 40.8 million tons in the 1980's under the "Western food strategy", compared with 20.5 million tons in set II-B. Another factor that might improve export earnings of the LDC's as a result of their freer access to markets of developed importers would be special trade considerations or preferences, thereby channeling more of the gains to these countries.

Projection Set III

In this projection set, the Green Revolution was assumed to be short-lived. The implications drawn from this set are compared with the projections of set I.

For the LDC's, grain export earnings would drop sharply. A substantial increase in their import costs could be softened by concessional terms from developed exporters, but the fall in exports more than offsets the

[45] The "observed" market trade prices most likely would not drop to the unrealistic levels suggested in app. tables A-2, A-3, and A-4. In periods of heavy supply, the "true" market price tends to be lower than the "observed" market price because special trade arrangements and concessions are not reflected in the market price.

increase in prices that would result from adjustments by the developed exporters. Furthermore, the higher world prices would adversely affect the less developed importers because reduced production would slow economic growth, which adds to the difficulty of importing food. To reduce the calorie gap, sizable concessional trade would be needed. On balance, this alternative shows that even if production in the LDC's should falter and have adverse effects on their economic development, production capacity in the developed world would be sufficiently large to prevent any real rise in grain prices. This agrees with conclusions in an earlier USDA study (*3*).

Commodity Prospects

Wheat—Fair

Import demand will be sluggish in the developed area but potentially strong in the LDC's if concessional terms of trade are available. Increased feed use of wheat would reduce downward pressure on prices. Some increase in the share of the world market would be possible for LDC exporters, largely Argentina. Accelerated wheat production in LDC's could lead to an improved export earnings position if major developed exporters moderated the price effect by withdrawing exportable supplies from the world market (as in the case of set II). Subsidy costs and quality factors could offset potential export earnings in South Asia.

Rice—Poor

The Green Revolution would result in lower world import demand, a demand centered in the LDC's. Import demand in the developed area is expected to rise moderately but the increase is small relative to potential supplies for exports—from both developed and less developed exporters. Consequently, continued downward pressures on prices are expected. Since most of the market for the LDC exporters is within the LDC's, prospects for export earnings from rice are poor, particularly under accelerated growth in rice production in the importing LDC's (as in sets II, II-A, and II-B).

Coarse Grains—Good

Import demand in developed areas, particularly Japan, is expected to be strong. Given concessional terms of trade, import demand of the LDC's could increase sharply as a result of a rapidly expanding livestock industry in these countries. Lower internal grain prices in developed importing areas, particularly the EC, could give trade an additional boost. Some LDC exporters might not fully share in the expansion because their port facilities are limited in handling large cargo vessels. On the other hand, maintenance of very high internal prices through limited access could lead to self-sufficiency in total grains in the EC, thereby lowering export prospects.

Table 34.--Total grains: Export earnings and import costs, 1964-66 average, and alternative projections to 1980 1/

Region	1964-66 2/		Proj. set I		Proj. set II		Proj. set III		Proj. set II-A		Proj. set II-B	
	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value	Import cost	Export value
	Million dollars											
Developed:												
United States		2,795.9		3,039.6		1,790.4		4,158.6		1,410.9		2,217.3
Canada	7.1	976.2	7.8	874.2	5.2	553.1	9.1	1,123.8	5.1	381.4	5.4	596.6
EC	774.9	83.2	669.8	245.7	521.5	136.8	729.7	335.9	355.5		687.2	
United Kingdom	561.0		422.7		435.8		446.4		349.1		470.9	
Other W. Europe	467.4		323.4	53.5	320.0	51.6	316.0	56.9	265.1		468.9	
Japan	782.3		1,559.0		1,384.8		1,667.9		903.4		1,297.6	
Australia & New Zealand		416.8		647.6		486.4		750.7		226.0		368.4
South Africa, Rep. of	35.8	25.5	71.1	224.5	58.8	158.8	78.1	275.7	25.2	55.5	32.8	97.2
Subtotal	2,628.5	4,297.6	3,053.8	5,085.1	2,726.1	3,177.1	3,247.2	6,701.6	1,903.4	2,073.8	2,962,8	3,279.5
Central plan:												
Eastern Europe	469.4		167.8	62.1	139.9	46.8	182.7	75.6	97.1	7.2	125.7	24.0
USSR	191.4	18.7	33.2	349.6	22.0	301.7	37.2	382.8	24.5	75.7	25.4	152.6
Communist Asia	437.2	141.7	463.2	92.2	413.5	41.3	490.1	120.8	248.5	38.6	342.9	41.5
Subtotal	1,098.0	160.4	664.2	503.9	575.4	389.8	710.0	579.2	370.1	121.5	494.0	218.1
Less developed:												
Cent. Am. & Mexico	132.7	41.4	345.2		188.6		458.8		143.6		179.6	5.8
Argentina		571.2		701.8		698.7		646.3		237.2		421.5
East South America	220.3	69.1	342.5	75.5	313.1	157.1	380.0	0.8	164.4	25.2	241.8	59.6
West South America	107.3		315.4		278.7	7.8	350.4		163.6	5.9	228.9	101.8
East Africa	54.8		109.0	71.5	78.5	152.2	126.7	0.2	65.2	62.6	78.3	49.6
West Africa	127.0	4.0	385.4		267.6		468.2		194.7		244.8	
North Africa	268.9	51.8	683.7	64.7	624.1	50.4	753.1	55.5	373.6	48.8	488.0	
West Asia	227.7		621.2		446.5		755.1		328.1		383.3	
South Asia	975.5		456.1		140.7	539.9	1,030.2		95.2	204.8	192.0	498.4
Southeast Asia	15.0	423.2	31.0	399.3	26.0	201.4	33.8	511.8	16.7	215.7	23.0	100.8
East Asia & Pac. Is	442.0		750.6		419.7		1,048.4		298.3		376.3	
Subtotal	2,571.2	1,160.7	4,040.1	1,312.8	2,783.5	1,807.5	5,404.7	1,214.6	1,843.4	800.2	2,436.0	1,237.5
World total	6,297.7	5,618.7	7,758.1	6,901.8	6,085.0	5,374.4	9,361.9	8,495.4	4,116.9	2,995.5	5,892.8	4,735.1

1/ Earnings or costs are on a net basis; therefore values are lower than actual levels. Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in set I. Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in set I.

2/ Import costs and export values calculated using net flows and standardized unit values to permit comparison with projected values in 1980.

REFERENCES

(1) Aarhus University
1969. Projections of Supply and Demand for Agricultural Products in Denmark (1970-1980). Economic Institut. Aarhus, Denmark.*

(2) Abbas, S.A.
1967. Supply and Demand of Selected Agricultural Products in Pakistan, 1961-1975. Oxford Univ. Press, Pakistan.*

(3) Abel, Martin E., and Rojko, Anthony S.
1967. World Food Situation. U.S. Dept. Agr., Econ. Res. Serv., Foreign Agr. Econ. Rpt. 35. Aug.

(4) Abel, Martin E., and Waugh, Frederick V.
1966. Measuring Changes in International Trade. Jour. of Farm Econ. Vol. 48. Nov.

(5) Ahalt, J. Dawson, and Egbert, Alvin C.
1965. The Demand for Feed Concentrates: A Statistical Analysis. Agr. Econ. Res. Vol. 17. Apr.

(6) Alm, Hans, Duloy, Jack, and Gulbrandsen, O.
1969. Agricultural Price and the World Food Economy. Progress Report for FAO, Mar. 1969. Also presented at the FAO Inter-Secretariat Expert Consultation on Projections, Rome, 15-19 Dec. 1969.

(7) Arthur D. Little, Inc.
1966. Projected Exports and Imports of Selected Agricultural Commodities of South Africa. Dec.*

(8) Asfour, Edmond Y.
1965. Saudi Arabia, Long-Term Projections of Supply of and Demand for Agricultural Products. Economic Research Institute, American Univ. of Beirut.*

(9) Austrian Institute for Economic Research (Vienna)
1964. Austria, Projected Level of Supply, Demand, and Trade of Agricultural Products in 1965 and 1975. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign 62. May.*

(10) Barker, R.
1969. Economic Aspects of High-yielding Varieties of Rice with Special Reference to National Price Policies. Mo. Bul. of Agric. Econ. and Stat. June.

(11) Barse, Joseph R.
1969. Japan's Food Demand and 1985 Grain Import Prospects. U.S. Dept. Agr., Econ. Res. Serv., Foreign Agr. Econ. Rpt. 53. June.

(12) _____
1970. Developed Countries' Agricultural Import Barricrs. U.S. Dept. Agr., Econ. Res. Serv. Unpublished manuscript.

(13) Bawden, D. Lee
1964. An Evaluation of Alternative Spatial Models. Jour. of Farm Econ. Vol. 46. pp. 1372-1379. Dec.

(14) _____
1966. A Spatial Price Equilibrium Model of International Trade. Jour. of Farm Econ. Vol. 48, pp. 862-874. Nov.

(15) Behrman, Jere R.
1968. Supply Response in Underdeveloped Agriculture. North-Holland Publishing Co. Amsterdam. A Case Study of Four Major Annual Crops in Thailand. 1937-1963.

(16) Berntson, B.L., Goolsby, O.H., and Nohrc, C.O.
1969. The European Community's Common Agricultural Policy. U.S. Dept. Agr., Econ. Res. Serv., Foreign Agr. Econ. Rpt. 55.

(17) Bieber, Robert A., and Hopkins, John T.
1970. Story of the 1960's: U.S. Rice in

World Trade. Foreign Agriculture. U.S. Dept. Agr. Mar. 9.

(18) Bjarnason, H.F.
1967. An Economic Analysis of 1980 International Trade in Feed Grains. Unpublished Ph.D. dissertation. Univ. of Wisc. May.

(19) Blakeslee, Leroy
1967. An Analysis of Projected World Food Production and Demand in 1970, 1985, and 2000. Vol. I. Unpublished Ph.D. dissertation. Iowa State Univ.

(20) Blau, Gerda
1963. International Commodity Arrangements and Policies, I and II. Monthly Bulletin of Agricultural Economics and Statistics. Food and Agriculture Organization. Rome. Sept. and Dec.

(21) Boeke, J.H.
1953. Economics and Economic Policy of Dual Societies. H.D. Tjienk Willink, Harlem. New York.

(22) Borthwick, Harry A.
1961. Light, Plowing, and the Production of Seed. The Yearbook of Agriculture 1961. U.S. Dept. Agr.

(23) Brandow, G.E.
1961. Interrelations Among Demands for Farm Products and Implications for Control of Market Supply. Penn. State Univ. Bul. 680. Univ. Park. Aug.

(24) Brown, Lester R.
1970. Seeds of Change. The Green Revolution and Development in the 1970's. Praeger Publishers.

(25) Centre De Recherches et De Documentation sur la Consommation
1967. Production and Uses of Selected Farm Products in Paris, France.*

(26) Consejo de Bienestar Rural
1965. Long-Term Forecasts of the Supply and Demand of Agricultural and Livestock Products in Venezuela. Jerusalem, Israel. Dec.*

(27) Crom, R., and Maki, W.
1965. Adjusting Dynamic Models to Improve their Predictive Ability. Jour. of Farm Econ. Vol. 47, pp. 963-972. Nov.

(28) Crosson, Pierre R.
1966. Economic Growth in Malaysia. Center for Development Planning, National Planning Association. Wash., D.C.*

(29) Dalrymple, Dana G.
1969. Technological Change in Agriculture: Effects and Implications for the Developing Countries. U.S. Dept. Agr., For. Agr. Serv. Apr.

(30) Dantwala, M.L.
1963. International Planning to Combat the Scourge of Hunger throughout the World. Annals of Collective Economy XXXIV. Jan.-Mar.

(31) Department of Economics, Monash University (Australia)
1968. Australia, Long-Term Projections of Agricultural Supply and Demand 1965 and 1980. May*

(32) Department of Political Economy, University of Edinburgh (Scotland)
1964. Ghana, Projected Level of Demand, Supply, and Imports of Agricultural Products in 1965, 1970, and 1975. Mar.*

(33) Economic Research Service
1964. World Food Budget 1970. U.S. Dept. Agr., Foreign Agr. Econ. Rpt. 19. Oct.

(34) Egbert, Alvin C., and Heady, Earl O.
1964. Regional Changes in Grain Production. An Application of Spatial Linear Programming. Agricultural and Home Economics Experiment Station, Iowa State Univ. Res. Bul. 521. Jan.

(35) Egbert, A.C., and Reutlinger, S.
1965. A Dynamic Model of the Livestock-Feed Sector. Jour. of Farm Econ. Vol. 47, pp. 1288-1305. Dec.

(36) Enke, S.
1963. Economics for Development. Prentice Hall. Englewood Cliffs, N.J.

(37) Epp, Donald J.
1968. Changes in Regional Grain and Livestock Prices under the European Economic Community Policies. Michigan State Univ.

(38) Falcon, W.P.
1962. Farmer Response to Price in Undeveloped Areas. A Case Study of West Pakistan. Unpublished Ph.D. dissertation. Dept. of Econ., Harvard Univ.

(39) Falcon, W.P.
1963. Real Effects of Foreign Surplus Disposal in Underdeveloped Economics. Further Comment. Quar. Jour. of Econ. Vol. 77. May.

(40) Filippello, A. Nicholas
1967. A Dynamic Econometric Investigation of the Japanese Livestock Economy. Unpublished Ph.D. dissertation. Univ. of Missouri. Dec.

(41) _____
1970. The Japanese Grain-Livestock Economy—An Econometric Projection to 1980 with Emphasis on Grain Imports. U.S. Dept. Agr., Econ. Res. Serv. Unpublished manuscript.

(42) Fletcher, L., and Mubyarto
1966. Supply and Market Surplus Relationships for Rice in Indonesia. Paper read at the Agricultural Development Council—University of Minnesota Conference on Supply and Market Relationships in Peasant Agriculture, Minneapolis. 18-20 Feb.

(43) Food and Agriculture Organization of United Nations
1963. Review of Trial and Demonstration Results, 1961-62, 1962-63 and 1963-64. Preliminary Freedom from Hunger Campaign Fertilizer Programme. Rome.

(44) _____
1966. Indicative World Plan for Agricultural Development 1965-85, Near East. Subregional Study No. 1, Vols. I and II. Rome.

(45) _____
1966. Relationships in World Prices of Coarse Grains and Some Implications for an International Grains Agreement. Mon. Bul. of Agr. Econ. and Stat. Vol. 15. Sept.

(46) _____
1966. Statistics of Crop Responses to Fertilizers.

(47) _____
1966. The Response of Rice to Fertilizer.

(48) _____
1967. Agricultural Commodities—Projections for 1975 and 1985. Vols. I and II. Rome.

(49) _____
1968. National Grain Policies. Rome. Selected issues.

(50) _____
1968. Indicative World Plan for Agricultural Development to 1975 and 1985, Asia and the Far East. Provisional Regional Study No. 4, Vols. I and II. Rome.

(51) _____
1968. Indicative World Plan for Agricultural Development to 1975 and 1985, South America. Provisional Regional Study No. 2, Vols. I and II. Rome.

(52) _____
1968. Trade Yearbook 1967. Vol. 21. Rome.

(53) _____
1969. Fertilizers, An Annual Review of World Production, Consumption, Trade and Prices, 1968. Rome.

(54) _____
1969. Indicative World Plan for Agricultural Development to 1975 and 1985, Africa, South of the Sahara. Provisional Regional Study No. 3, Vols. I and II. Rome.

(55) _____
1969. Provisional Indicative World Plan for Agricultural Development. Vols. I-III. Rome. Aug.

(56) _____
1969. Trade Yearbook 1968. Vol. 22. Rome.

(57) Friend, Reed E., and Butell, G. Robert
1969. Production, Consumption, and Trade of Coarse Grains, Developments and Prospects for Selected Foreign Countries and Areas. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign 272.

(58) Frisch, Ragnar
1959. A Complete Scheme for Computing All Direct and Cross Demand Elasticities in a Model With Many Sectors, Econometrica, Vol. 27, No. 2.

(59) Goreux, L.
1957. Long-range Projections of Food Consumption. Mo. Bul. of Agric. Econ. and Stat. June.

(60) _____
1960. Income and Food Consumption. Mo. Bul. of Agric. Econ. and Stat. Oct.

(61) Griliches, Zvi
1957. Specification Bias in Estimates of Production Functions. Jour. of Farm Econ. Vol. 34. Dec.

(62) Gulbrandsen, Odd
1967. A Model for Projections of World Food Prices and Balance. Unpublished manuscript. Mar. 4.

(63) Halvorson, Harlow
1967. Food and Fiber for the Future. Nat. Advisory Comm. on Food and Fiber. Wash., D.C. July.

(64) Hardin, Clifford M.
1969. Overcoming World Hunger. The American Assembly. Prentice-Hall, Inc. Englewood Cliffs, N.J.

(65) Harrar, J.B., and Wortman, S.
1969. Expanding Food Production in Hungry Nations: The Promise, The Problems. In C.M. Hardin, ed. Overcoming World Hunger. Prentice-Hall, Inc. Englewood Cliffs, N.J.

(66) Harris, Alan J.
1967. An Economic Analysis of Rice Prices in the Republic of Vietnam. Dept. of Agr. Econ.,North Dakota St. Univ., Agr. Econ. T. Series 67-1. Dec.

(67) Hendrix, William E., Naive, James J. and Adams, Warren
1968. Accelerating India's Good Grain Production 1967-69 to 1970-71. U.S. Dept. Agr., Econ. Res. Serv. Foreign Agr. Econ. Rpt. 40. Mar.

(68) Hogg, V.W.
1960. Response to Price in an Underdeveloped Economy. Econ. Jour. Vol. 70, pp. 852-855. Dec.

(69) Hsiech, S.C., and Ruttan, V.W.
1967. Environmental, Technological, and Institutional Factors in Growth Production: Philippines, Thailand and Taiwan. Food Res. Inst. Stud. Vol. VII, No. 3.

(70) Hsu, Wen-Fu
1967. Demand Projections of Agricultural Products Relative to Economic Development in Taiwan. Res. Instit. of Rural Socio-Economics, National Taiwan University. Taipei, Taiwan. Dec.

(71) Hutchison, John E., Naive, James J., and Tsu, Sheldon K.
1970. World Demand Prospects for Wheat in 1980 with Emphasis on Trade by the Less Developed Countries. U.S. Dept. Agr., Econ. Res Serv., Foreign Agr. Econ. Rpt. 62. July.

(72) IFO-Insuitut fur Wirtschaftsforschung
1967. Long-Term Development of Demand and Supply for Agricultural Products in the Federal Republic of Germany. Munich.*

(73) Institute for Agricultural Economic Research, Univ. of Tokyo
1964. Japanese Import Requirement: Projections of Agricultural Supply and Demand for 1965, 1970, and 1975. Mar.*

(74) Institute of Social and Economic Research, Univ. College of the West Indies
1966. Jamaica, Trinidad and Tobago, Leeward

Islands, Windward Islands, Barbados, and British Guiana, Projected Levels of Demand, Supply and Imports of Agricultural Products to 1975. U.S. Dept. Agr., Econ. Res. Serv., ERS-Forcign 94.*

(75) International Wheat Council
1968. International Grains Arrangement 1967 and Rules of Proccdure. Wheat Trade Convention.

(76) _____
Review of the World Grains Situation. London. Selected issues.

(77) Jean, Clancy V.
1969. The Story of the 1960's: U.S. Wheat in World Trade. Foreign Agriculture. U.S. Dept. Agr. Nov. 24.

(78) Johnson, Harry G.
1967. Economic Policies Toward Less Developed Countries. Frederick A. Praeger, Inc. New York.

(79) Jones, G.T.
1969. United Kingdom: Projected Level of Demand, Supply and Imports of Agricultural Products, 1970, 1975 and 1980. The Univ. of Oxford Institute for Research in Agricultural Economics.*

(80) Keefer, James F., Barry, Robert D., Pike, Clarence E., and Gill, Amjad H.
World Supply and Demand Prospects for Rice in 1980 With Emphasis on Trade Implications for Less Developed Countries. U.S. Dept. Agr., Econ. Res. Serv. Unpublished manuscript.

(81) Krishna, R.
1963. Farm Supply Response in India-Pakistan. A Case Study of the Punjab Region. The Econ. Jour. Vol. 73 Sept.

(82) Krishna R.
1965. The Marketable Surplus Function for Subsistence Crops. An Analysis with Indian Data. The Econ. Weekly, Vol. 17. Feb.

(83) Krishnan, T.N.
1965. The Marketed Surplus of Foodgrains: Is it Inversely Related to Price? The Econ. Weekly. Vol. 16 (Annual number), pp. 325-328. Feb.

(84) Landbouw-Economisch Instituut
1967. Supply and Demand, Imports and Exports of Selected Agricultural Products in the Netherlands. Forecast for 1970 and 1975. The Hague.*

(85) Leath, Mack N., and Martin, James E.
1967. Formulation of a Transshipment Problem Involving Time. Agr. Econ. Res., Vol. 19, pp. 7-14. Jan.

(86) Leftwich, R.H.
1961. The Price System and Resource Allocation. Holt, Rinehart and Winston. New York.

(87) Lieftinch, Peter, Sadove, Robert A., Creyke, Thomas C.
1969. Water and Power Resources of West Pakistan. A Study in Sector Planning. Vol. 2, pp. 411-419, and Vol. 3, pp. 17-61.

(88) Macbeam, Alasdair, I.
1967. Export Instability and Economic Development. Harvard Univ. Press, Cambridge, Mass.

(89) Mackie, Arthur B., and Filippello A. Nicholas, Hutchison, John E., and Keefer, James F.
1968. World Trade in Selected Agricultural Commodities, 1951-65. Vol. 2., Food and Feed Grains. U.S. Dept. Agr., Econ. Res. Serv., Foreign Agr. Econ. Rpt. 45. June.

(90) Mangahas, Mahar, Recto, Aida E., and Ruttan, V.W.
1966. Market Relationships for Rice and Corn in the Philippines. Jour. of Farm Econ. Vol. 48. Aug.

(91) McCalla, Alex F.
1966. A Duopoly Model of World Wheat Pricing. Jour. of Farm Econ. Vol. 48. Aug.

(92) Meir, Gerald M.
1963. International Trade and Development. Harper and Row, New York.

(93) Mellor, J.
1967. Towards a Theory of Agricultural

Development. In H.M. Southworth and B.F. Johnston, eds. Agr. Development and Econ. Growth. Ithaca, N.Y.

(94) Mellor, John W.
1968. The Functions of Agricultural Prices in Economic Development. Dept. of Agr. Econ. Cornell Univ., Ithaca, N.Y. Reprinted from the Indian Jour. of Agr. Econ., Vol. 23. No. 1. Jan.-Mar.

(95) Mellor, John W., and Dar, Ashok K.
1968. Determinants and Development Implications of Foodgrains Prices in India, 1959-1964. Am. Jour. Agr. Econ. Vol. 50. Nov.

(96) Mercantile, Inc.
1963. The Philippines, Long-Term Projections of Supply of and Demand for Selected Agricultural Products. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign 34.*

(97) Mo, William Y.
1968. An Economic Analysis of the Dynamics of the United States Wheat Sector. U.S. Dept. Agr., Econ. Res. Serv., Tech. Bul. 1395. Apr.

(98) Moe, Lyle E.
1968. World Population and Income by Countries 1950-65 and Projections to 1980. Working paper prepared as part of the research project on Demand Prospects for Agricultural Products of Less Developed Countries. U.S. Dept. Agr. Econ. Res. Serv. Oct.

(99) Mohtadi, Malek M.
1968. Iran Input-Output Model, 1965. Unpublished report.

(100) Mundlak, Yair
1964. Long-Term Projections of Supply and Demand for Agricultural Products in Israel. Hebrew Univ. Jerusalem. May.*

(101) Mubyarto
1965. The Elasticity of the Marketable Surplus of Rice in Indonesia. Unpublished Ph.D. dissertation. Iowa State Univ.

(102) National Council of Applied Economic Research
1962. Long-Term Projections of Demand for and Supply of Selected Agricultural Commodities 1960-61 to 1975-76 (India). New Delhi. Apr.*

(103) _____
1967. All-India Consumer Expenditure Survey. Vol. I Methodology and Vol. II Patterns of Income and Expenditure. New Delhi.

(104) _____
1970. Projections of Demand and Supply of Agricultural Commodities. New Delhi. Sept.

(105) Nerlove, M.
1956. Estimates of the Elasticities of Supply of Selected Agricultural Commodities. Jour. of Farm Econ. Vol. 37, pp. 496-509.

(106) _____
1958. The Dynamics of Supply: Estimation of Farmers' Response to Price. John Hopkins Univ. Press, Baltimore.

(107) Newmark, S.D.
1959. Some Economic Problems of African Agriculture. Jour. of Farm Econ. Vol. 41. Feb.

(108) Ohkawa, K.
1964. Concurrent Growth of Agriculture with Industry. A Study of the Japanese Case. In R.N. Dixey, ed. International Explorations of Agricultural Econ. Ames, Iowa.

(109) Olson, R.O.
1960. The Impact and Implications of Foreign Surplus Disposal on Underdeveloped Economies. Jour. of Farm Econ. Vol. 42. Dec.

(110) Organization for Economic Cooperation and Development
1968. Agricultural Projections for 1975 and 1985, Europe, North America, Japan and Oceania, Production and Consumption of Major Foodstuffs. Paris.

(111) _____
1968. Agricultural Projections for 1975 and 1985; Country Studies. Paris.

(112) ———
1968. Supply and Demand Prospects for Fertilizers in Developing Countries. Paris.

(113) ———
1966. Demographic Trends 1965-80 in Western Europe and North America. Paris.

(114) Oury, Bernard
1963. A Tentative Production Model for Wheat and Feed grains in France, 1946-1961. Unpublished Ph.D. dissertation. Univ. of Wisc.

(115) Regier, Donald W.
1967. Growth in Demand for Feed Grains in the EC. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign 158. July.

116) Regier, Donald, and Goolsby, O.H.
1970. Growth in World Demand for Feed Grains Related to Meat and Livestock Products and Human Consumption of Grain. U.S. Dept. Agr., Econ. Res. Serv., Foreign Agr. Econ. Rpt. 63. July.

(117) Reutlinger, Shlomo
1966. Analysis of a Dynamic Model with Particular Emphasis on Long-Run Projections. Jour. of Farm Econ. Vol. 48, pp. 88-105. Feb.

(118) Rockefeller Foundation Annual Report
1967. Program in the Agricultural Sciences. New York.

(119) Rojko, Anthony S., and Mackie, Arthur B.
1970. World Demand Prospects for Agricultural Exports of Less Developed Countries in 1980. U.S. Dept. Agr., Econ. Res. Ser., Foreign Agr. Econ. Rpt. 60. June.

(120) Roger, W. Fox
1967. Estimating the Effects of the EC Common Grain Policy. Jour. of Farm Econ. Vol. 49, pp. 372-388. May.

(121) Sahota, G.S.
1968. Fertilizer in Economic Development. New York.

(122) Samuelson, Paul A.
1952. Spatial Price Equilibrium and Linear Programming. Am. Econ. Rev. Vol. 42, pp. 283-303. June.

(123) Schmitz, Andrew
1968. An Economic Analysis of the World Wheat Economy in 1980. Unpublished Ph.D. dissertation. Univ. of Wisc.

(124) Schultz, T.W.
1964. Transforming Traditional Agriculture. Yale Univ. Press. London and New Haven.

(125) ———
1965. Economic Crises in World Agriculture. The Univ. of Michigan Press. Ann Arbor, Mich.

(126) Secretaria de Agricultura Y Ganaderia, Secretaria de Hacienda y Credito Publico Banco de Mexico, S.A.
1966. Projections of Supply of and Demand for Agricultural Products in Mexico to 1965, 1970, and 1975.*

(127) Sinha, R.P.
1966. An Analysis of Food Expenditures in India. Jour. of Farm Econ. Vol. 48. Feb.

(128) Sitler, Harry G. and Skold, Melvin D.
1969. Aggregate Supply Responses for Eastern Colorado Wheat Farmers. U.S. Dept. Agr., Econ. Res. Serv. Colorado State Univ. Experiment Station. Fort Collins. Apr.

(129) Smith, V.L.
1962. An Experimental Study of Competitive Market Behaviour. Jour. of Pol. Econ. Vol. 50., pp. 111-137.

(130) Sorenson, Vernon L., and Hathaway, Dale E.
1968. The Grain-Livestock Economy and Trade Patterns of the European Economic Community. Institute of International Agriculture. Mich. State Univ.

(131) Southworth, Herman M., and Johnson, Bruce F., editors
1967. Agricultural Development and Economic Growth. Cornell Univ. Press. Ithaca, N.Y.

(132) Stevens, Robert
1965. Elasticity of Food Consumption Associated with Changes in Income in Developing Countries. U.S. Dept. Agr., Econ. Res. Serv., Foreign Agr. Econ. Rpt. 23.

(133) Studiecentrum Voor Economisch En Sociaal Onderzoek
1967. Long-Term Development of Supply and Demand for Agricultural Products in Belgium 1970-1975.*

(134) Takayama, T.
1967. International Trade and Mathematical Programming. The Aust. Jour. of Agr. Econ., Vol. 11, pp. 36-48. June.

(135) Takayama, T. and Judge, G.G.
1964. Equilibrium Among Spatially Separated Markets: A Reformulation. Econometrica, Vol. 32, pp. 510-524. Oct.

(136) _____
1964. An Interregional Activity Analysis Model for Agricultural Sector. Jour. of Farm Econ. Vol. 46, pp. 349-365. May.

(137) _____
1964. An Intertemporal Price Equilibrium Model. Jour. of Farm Econ. Vol. 46, pp. 477-484. May.

(138) _____
1964. Spatial Equilibrium and Quadratic Programming. Jour. of Farm Econ. Vol. 46, pp. 67-93. Feb.

(139) Thomasson, Larry F.
1970. The Story of the 1960's: U.S. Feedgrains in World Trade. Foreign Agriculture. U.S. Dept. Agr. Jan. 19.

(140) United Nations
1966. World Population Prospects as Assessed in 1963. Dept. Econ. and Soc. Affairs, Population Studies No. 41. New York.

(141) _____
1967. Fertilizer Manual. New York.

(142) _____
1968. Special Measures to be Taken in Favo of the Least Developed Among th Developing Countries. Rpt. by th UNCTAD Secretariat. Jan. Conferenc on Trade and Development.

(143) _____
1969. Monthly Bulletin of Statistics. Mar.

(144) _____
1969. International Trade 1968. Genera Agreements on Tariffs and Trade. Geneva.

(145) University of Edinburgh
1962. Nigeria: Determinants of Projected Level of Demand, Supply and Imports of Farm Products in 1965 and 1975. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign 32. Aug.*

(146) U.S. Agency for International Development, Office of Program Coordination
1967. Gross National Product: Growth Rates and Trend Data by Region and Country. RC-W-138. Mar.

(147) U.S. Department of Agriculture
1967. International Grains Arrangement. For. Agr . Serv., FAS-M-195. Nov.

(148) Waugh, Frederick V.
1964. Demand and Price Analysis, Some Examples from Agriculture. U.S. Dept. Agr., Econ. Res. Serv., Tech. Bull. 1316. Nov.

(149) White House, The
1967. The World Food Problem. A Report of the President's Science Advisory Committee, Vol. 2, May.

(150) Willett, Joseph W.
1969. The Impact of New Grain Varieties in Asia. U.S. Dept. Agr., Econ. Res. Serv. ERS-Foreign 275.

*Part of a study conduction under contract with the USDA as part of a series to evaluate long-term supply and demand prospects for agricultural products throughout the world. The complete study may be obtained on request from the Division of Information, Office of Management Services, U.S. Dept. of Agriculture, Wash., D.C. 20250.

APPENDIX A.--MATHEMATICAL RELATIONSHIPS IN THE WORLD GRAIN MODEL

The mathematical relationships used in the World Grain Model are shown on the following pages. The world model has two parts--model I and model II. Most of the relationships are common to both of these. Those that pertain to only one of the models are so identified.

To facilitate identification, relationships are preceded by two regional codes, an alphabetical one and a numerical one. Those which are not preceded by a code are general to the whole system.

The variables on the left-hand side of the equations are endogenous and are jointly determined by the model. Those on the right-hand side and those in parentheses are exogenous (their values are given or assumed) and they jointly determine endogenous values.

The variables are generally identified by letter symbols. The first two letters identify the type of variable, the third letter identifies the grain (W=wheat, R=Rice, and C=coarse grains), and the last three letters identify the region. When there is deviation from this system, an explanation is given.

Variables

QS = quantity supplied (produced)
QD = quantity demanded
PS = supply price
PD = demand price
PW = wholesale price
PT = trade price (import price in importing regions or export price in exporting regions)
PB = base price
RP = simplex miltipliers (see note, p.124)
T = trend
TC = transportation cost per ton of heavy grain among regions
QT = quantity transported (shipped) and QT_{ijk} = quantity transported of commodity i from region j to region k
TE = total exports
EW, ER, EC = exports of wheat, rice, and coarse grains, respectively, from individual regions
DS = demand for stocks (change in stocks)
DA = demand for aid in commodity surplus region
AD = demand for aid in commodity deficient region
QDFW = demand for wheat for feed use (as distinguished from QDW, demand for wheat for human consumption)

Regions

USA	01.	United States	
CAN	02.	Canada	
CAM	03.	Cent. Am. & Mexico.....	British Honduras, Caribbean including Cuba, Costa Rice, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama.
ESA	04.	East South America.....	Brazil, French Guiana, Guiana, Paraquay, Surinam, Uruguay, Venezuela.
WSA	05.	West South America.....	Bolivia, Chile, Colombia, Ecuador, Peru.
ARG	06.	Argentina	
UKI	07.	United Kingdom	
EEC	08.	European Community.....	Belgium-Luxembourg, France, Germany-Fed. Rep., Italy, Netherlands

OWE	09.	Other Western Europe.....	Austria, Denmark, Finland, Greece, Iceland, Ireland, Malta, Norway, Portugal, Spain, Sweden, Switzerland.
EEU	10.	Eastern Europe.....	Albania, Bulgaria, Czechoslovakia, Germany (E), Hungary, Poland, Romania, Yugoslavia.
SUN	11.	Soviet Union	
NAF	12.	North Africa.....	Algeria, U.A.R. (Egypt), Libya, Morocco, Sudan, Tunisia.
WAS	13.	West Africa.....	Angola, Cameroon, Central African Rep., Chad, Congo (Kinshasa), Congo (Brazz.), Dahomey, Gabon, Gambia, Ghana, Guinea, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Portuguese Guinea, Senegal, Sierra Leone, Togo, Upper Volta, Other Portuguese West Africa.
EAF	14.	East Africa.....	Botswana, Burundi, Ethiopia, Kenya, Lesotho, Malagasy Rep., Malawi, Mauritius, Mozambique, Rhodesia, Rwanda, Somalia, Swaziland, Tanzania, Uganda, Zambia.
SAF	15.	South Africa, Rep.	
WAS	16.	West Asia.....	Bahrein, Cyprus, Iran, Iraq, Israel, Jordon, Kuwait, Lebanon, Muscat & Oman, Qatar, Saudi Arabia, South Yeman, Syria, Trucial States, Turkey, Yemen.
SAS	17.	South Asia.....	Afghanistan, Bhutan, Ceylon, India, Nepal, Pakistan.
SEA	18.	Southeast Asia.....	Burma, Cambodia, Laos, South Vietnam, Thailand.
CAS	19.	Communist Asia.....	China, Mongolia, North Korea, North Vietnam.
JAP	20.	Japan	
EAP	21.	East Asia & Pacific Is....	Brunei, China (Taiwan), Hong Kong, Indonesia, Korea, Macao, Malaysia, Pacific Islands, Papua, Philippines, Singapore.
ANZ	22.	Australia & New Zealand	

Supply equations - wheat

USA - 01: QSW - 133.176 PSW + 111.707 PSC + 0.400 DSW = 42,026.100 = (33,704.100 + 328.0 T)

CAN - 02: QSW - 109.969 PSW + 23.136 PSC + 0.300 DSW = 13,230.817 = (12,626.820 - 239.7 T)

CAM - 03: QSW - 7.647 PSW + 0.842 PSR + 5.031 PSC = 3,123.239 = (1,818.239 + 87.0 T)

ESA - 04: QSW - 1.584 PSW + 0.789 PSR + 1.316 PSC = 1,091.789 = (746.789 + 23.0 T)

WSA - 05: QSW - 4.614 PSW + 0.301 PSR = 1,625.448 = (1,340.448 + 19.0 T)

ARG - 06: QSW - 54.979 PSW + 28.391 PSC = 8,320.459 = (6,525.459 + 66.3 T)

UKI - 07: QSW - 21.789 PSW + 14.865 PSC = 3,726.660 = (3,126.660 + 40.0 T)

EEC - 08: QSW - 90.191 PSW + 40.539 PSC =31,082.380 = (23,582.380 + 500.0 T)

OWE - 09: QSW - 27.422 PSW + 25.252 PSC =10,879.780 = (9,079.780 + 120.0 T)

EEU - 10: QSW - 64.148 PSW + 30.990 PSC=28,796.679 = (18,971.679 + 655.0 T)

SUN - 11: QSW - 202.690 PSW + 10.511 PSC =72,309.269 = (51,084.269 + 1,415.0 T)

NAF - 12: QSW - 14.253 PSW + 0.740 PSC = 4,125.200 = (2,925.200 + 80.0 T)

WAF - 13: QSW - 0.035 PSW = 38.400 = (23.400 + 7.0 T)

EAF - 14: QSW - 0.646 PSW = 735.600 = (435.600 + 20.0 T)

SAF - 15: QSW - 2.120 PSW + 1.711 PSC = 879.500 = (654.500 + 15.0 T)

WAS - 16: QSW - 15.594 PSW + 6.036 PSC = 17,001.750 = (11,601.750 + 360.0 T)

SAS - 17: QSW - 34.622 PSW + 28.717 PSR + 14,578 PSC = 44,253,439= (18,003.439 + 1,750.0 T)

SEA - 18: QSW - 0.082 PSW = 96.600 = (66.600 + 2.0 T)

CAS - 19: QSW - 39.883 PSW = 28,396.400 = (18,346.400 + 670.0 T)

JAP - 20: QSW - 3.593 PSW + 0.958 PSR + 1.481 PSC = 759.448 (1,149.448 - 26.0 T)

EAP - 21: QSW - 0.577 PSW = 385.600 = (265.600 + 8.0 T)

ANZ - 22: QSW - 82.315 PSW + 0.200 DSW = 7,017.200 = (6,124.200 + 20.8 T)

Supply equations - rice

USA - 01: QSR - 3.745 PSR = 2,762.400 = (2,042.400 + 48.0 T)

CAM - 03: QSR + 0.806 PSW - 1.972 PSR = 1,118.850 = (458.850 + 44.0 T)

ESA - 04: QSR + 0.482 PSW -24.034 PSR + 8.018 PSC = 5,928.059 = (3,228.059 + 180.0 T)

WSA - 05: QSR + 0.609 PSW - 1.590 PSR = 1,284.751 = (639.751 + 43.0 T)

ARG - 06: QSR - 0.940 PSR = 204.600 = (84.600 + 8.0 T)

EEC - 08: QSR - 0.906 PSR = 347.100 = (287.100 + 4.0 T)

OWE - 09: QSR - 0.917 PSR = 415.40 = (295.400 + 8.0 T)

EEU - 10: QSR - 0.186 PSR = 99.300 = (69.300 + 2.0 T)

SUN - 11: QSR - 0.620 PSR = 1,123.701 + (238.701 + 59.0 T)

NAF - 12: QSR - 3.717 PSR + 1.402 PSC = 2,053.760 = (988.760 + 71.0 T)

WAF - 13: QSR - 1.446 PSR = 1,725.900 = (1,470.900 + 27.0 T)

EAF - 14: QSR - 2.264 PSR = 1,250.200 = (815.200 + 29.0 T)

SAF - 15: QSR - 0.002 PSR = 4.801 = (1.801 + 0.20 T)

WAS - 16: QSR - 0.921 PSR = 1,305.750 = (690.750 + 41.0 T)

SAS - 17: QSR + 13.760 PSW - 142.669 PSR + 19.313 PSC = 60,518.360 = (35,318.360 + 1,680.0 T)

SEA - 18: QSR -112.092 PSR + 3.875 PSC = 19,509.151 = (12,264.151 + 483.0 T)

CAS - 19: QSR - 94.707 PSR = 75,816.600 = (58,641.600 + 1,145.0 T)

JAP - 20: QSR + 1.736 PSW - 13.705 PSR + 1.431 PSC = 6,971.611 = (7,211.611 - 16.0 T)

EAP - 21: QSR - 48.728 PSR + 3.191 PSC = 24,535.569 = (17,035.569 + 500.0 T)

ANZ - 22: QSR - 0.480 PSR = 200.200 = (95.200 + 7.0 T)

Supply equations - coarse grains

USA - 01: QSC + 128.209 PSW - 860.321 PSC = 176,714.250 = (102,464.250 + 4,950.0 T)

CAN - 02: QSC + 30.821 PSW - 98.807 PSC = 15,438.749 = (10,563.749 + 325.0 T)

CAM - 03: QSC + 4.493 PSW - 44.335 PSC = 15,023.440 = (8,123.440 + 460.0 T)

ESA - 04: QSC + 1.139 PSW + 2.838 PSR - 113.616 PSC = 16,832.229 = (8,432.229 + 560.0 T)

WSA - 05: QSC + 1.195 PSW - 8.423 PSC = 2,719.039 = (2,314.039 + 27.0 T)

ARG - 06: QSC + 37.666 PSW - 74.808 = 12,399.759 = (7,899.759 + 300.0 T)

UKI - 07: QSC + 8.138 PSW - 50.473 PSC = 11,865.439 = (7,215.439 + 310.0 T)

EEC - 08: QSC + 54.846 PSW - 90.632 PSC = 47,068.040 = (28,393.040 + 1,245.0 T)

OWE - 09: QSC + 17.364 PSW - 63.119 PSC = 24,872.999 = (16,472.999 + 560.0 T)

EEU - 10: QSC + 20.295 PSW - 118.843 PSC = 48,046.759 = (36,496.759 + 770.0 T)

SUN - 11: QSC + 24.863 PSW - 171.917 PSC = 69,207.249 = (42,807.249 + 1,760.0 T)

NAF - 12: QSC + 1.474 PSW + 3.043 PSR - 11.478 PSC = 10,848.298 = (6,198.298 + 310.0 T)

WAF - 13: QSC - 12.357 PSC = 12,858.900 = (10,008.900 + 190.0 T)

EAF - 14: QSC - 26.293 PSC = 18,790.500 = (10,885.500 + 525.0 T)

SAF - 15: QSC + 0.563 PSW - 28.378 PSC = 9,732.079 = (3,882.079 + 390.0 T)

WAS - 16: QSC + 1.038 PSW - 13.398 PSC = 10,259.370 = (7,559.370 + 180.0 T)

SAS - 17: QSC + 5.170 PSW + 16.081 PSR - 54.421 PSC = 33,923.000 = (22,748.00 + 745.0 T)

SEA - 18: QSC + 2.434 PSR - 9.179 PSC = 3,189.779 = (1,164.779 + 135.0 T)

CAS - 19: QSC - 167.643 PSC = 57,127.000 = (37,552.000 + 1,305.0 T)

JAP - 20: QSC + 1.528 PSW + 1.379 PSR - 7.200 PSC = 1,076.396 = (1,526.396 - 30.0 T)

EAP - 21: QSC + 1.751 PSR - 22.936 PSC = 10,880.259 = (5,330.259 + 370.0 T)

ANZ - 22: QSC - 21.914 PSC = 5,348.700 = (2,198.700 + 210.0 T)

Demand equations - wheat

USA - 01: QDW + 19.682 PDW - 35.840 PDC = 22,262.096 = (7,451.042 - 2.735 Y + 95.8 P)

CAN - 02: QDW + 12.020 PDW - 11.342 PDC = 3,762.007 = (622.897 - 0.300 Y + P + 212.20 T)

CAM - 03: QDW + 11.146 PDW - 1.594 PDR - 7.086 PDC=5,633.585=(-1001.452+2.990 Y+35.000 P + 25.0 T)

ESA - 04: QDW + 7.263 PDW - 2.311 PDR - 10.034 PDC = 6,088.579 = (-762.868 + 2.297 Y+39.7 P)

WSA - 05: QDW + 6.302 PDW - 1.253 PDR - 5.318 PDC=5,188.295=(-991.161+2.634 Y+59.500 P + 50.0 T)

ARG - 06: QDW + 17.704 PDW - 4.953 PDC = 5,694.187 = (2,124.830 - 1.614 Y + 172.800 P + 10.0 T)

UKI - 07: QDW + 25.519 PDW - 11.501 PDC = 9,476.765 = (2,448.353 - 1.653 Y + 149.600 P + 18.0 T)

EEC - 08: QDW + 76.811 PDW - 60.507 PDC = 33,812.472 = (2,471.505 + 154.200 P + 50.0 T)

OWE - 09: QDW + 30.003 PDW - 24.213 PDC = 11,773.273 = (4,597.016 - 6.194 Y + 131.2 P + 18.0 T)

EEU - 10: QDW + 59.029 PDW - 25.000 PDC = 35,698.484 = (561.736 - 3.784 Y + 218.5 P)

SUN - 11: QDW + 154.059 PSW - 163.688 PDC = 79,790.227 = (7.660 + 283.900 P + 70.0 T)

NAF - 12: QDW + 14.650 PDW - 0.669 PDR - 4.930 PDC = 15,268.893 = (-1,303.408 + 13.110 Y + 103.100 P + 1

WAF - 13: QDW + 3.437 PDW - 1.161 PDR - 2.114 PDC = 1,423.453 = (-558.188+4.194Y+4.900 P + 30.0 T)

EAF - 14: QDW + 3.322 PDW - 0.614 PDR - 3.494 PDC = 1,453.354 = (-513.286+4.880 Y + 9.300 P + 15.0 T)

SAF - 15: QDW + 3.098 PDW - 1.893 PDC = 1,998.452 = (226.859 + 63.600 P + 5.0 T)

WAS - 16: QDW + 28.844 PDW - 0.401 PDR - 7.211 PDC = 25,026.933 = (-719.572 + 9.519 Y + 164.0 P)

SAS - 17: QDW - 0.600 QSW + 0.700 QSR + 107.476 PDW-23.692 PDR - 5.331 PDC = 76,445.543
=(-2,149.395 + 106.616 Y + 41.800 P + 240.0 T)

SEA - 18: QDW + 0.810 PDW - 0.735 PDR = 578.738 = (-36.346 + 0.730 Y + 3.100 P + 10.0 T)

CAS - 19: QDW + 21.226 PDW = 41,953.059 = (2,878.755 + 36.000 P + 20.0 T)

JAP - 20: QDW + 9.238 PDW - 11.780 PDR = 5,396.657 = (-2,476.609 + 1.337 Y + 48.600 P + 75.0 T)

EAP - 21: QDW + 8.926 PDW - 3.715 PDR - 5.891 PDC=4,430.490=(-1,173.939+6.837 Y+12.100 P + 50.0 T)

ANZ - 22: QDW + 5.037 PDW = 3,074.432 = (816.036 - 0.532 Y + 194.300 P - 35.0 T)

Demand equations - rice

USA - 01: QDR + 0.470 PDR = 1,476.071 = (10.058 + 0.094 Y + 4.9 P)

CAN - 02: QDR + 0.034 PDR = 76.608 = (5.101 + 0.006 Y + 2.3 P)

CAM - 03: QDR - 0.200 QSR - 3.006 PDW + 1.911 PDR - 0.637 PDC = 1,684.000 = (-155.709 + 0.806 Y + 12.9 P)

ESA - 04: QDR - 0.400 QSR - 8.589 PDW + 8.198 PDR - 5.993 PDC = 4,387.000 = (-672.101 + 2.716 Y + 46.9 P)

WSA - 05: QDR - 0.300 PSR - 1.027 PDW + 1.225 PDR = 1,228.000 = (-92.550 + 0.858 Y + 19.4 P)

ARG - 06: QDR - 0.090 PDW + 0.221 PDR = 234.341 = (-6.158 + 0.049 Y + 5.300 P + 3.0 T)

UKI - 07: QDR + 0.125 PDR = 173.980 = (21.571 + 0.022 Y + 2.0 P)

EEC - 08: QDR + 0.577 PDR = 957.683 = (65.645 + 0.162 Y + 3.6 P)

OWE - 09: QDR + 0.414 PDR = 689.644 = (68.701 + 0.120 Y + 5.2 P)

EEU - 10: QDR + 0.348 PDR = 592.568 = (78.511 + 0.055 Y + 3.2 P)

SUN - 11: QDR + 0.519 PDR = 1,652.703 = (-105.625 + 0.308 Y + 2.500 P + 20.0 T)

NAF - 12: QDR - 0.100 QSR - 3.657 PDW + 2.087 PDR - 3.692 PDC = 1,314.000 = (-770.466 + 3.273 Y + 12.900 P + 5.0 T)

WAF - 13: QDR - 1.092 PDW + 3.842 PDR - 2.141 PDC = 2,988.765 = (23.010 + 3.172 Y + 13.0 P)

EAF - 14: QDR - 1.010 PDW + 1.998 PDR - 3.426 PDC = 1,913.565 = (-573.428 + 6.180 Y + 14.1 P)

SAF - 15: QDR + 0.110 PDR = 156.160 = (0.001 + 0.056 Y + 4.200 P + 1.0 T)

WAS - 16: QDR - 2.993 PDW + 1.062 PDR - 2.231 PDC = 1,989.318 = (-470.856 + 1.262 Y + 14.5 P)

SAS - 17: QDR + 0.200 QSW - 0.800 QSR - 34.117 PDW + 78.342 PDR - 4.701 PDC = 32,760.380 =(-4,720.818 + 141.015Y+73.700P-90.0 T)

SEA - 18: QDR - 0.100 QSR + 37.095 PDR = 23,053.000 = (1,594.082 + 196.800 P - 60.0 T)

CAS - 19: QDR + 39.390 PDR = 94,018.032 = (6,314.563 + 79.200 P - 320.0 T)

JAP - 20: QDR - 10.520 PDW + 11.805 PDR = 13,026.969 = (2,981.960 - 3.349 Y + 121.7 P)

EAP - 21: QDR - 0.500 QSR - 2.903 PSW + 24.494 PDR - 2.177 PDC = 21,246.000 = (1,365.170 + 27.794 Y + 98.700P-290.0 T)

ANZ - 22: QDR + 0.088 PDR = 88.850 = (4.592 + 0.009 Y + 3.1 P + 1.0 T)

Demand equations - coarse grains

USA - 01: QDC - 65.737 PDW + 957.631 PDC = 218,593.629 = (-18,673.605 + 27.410 Y + 639.8 P)

CAN - 02: QDC - 29.265 PDW + 122.736 PDC = 22,626.472 = (675.335 + 2.924 Y + 688.700 P - 110.0 T)

CAM - 03: QDC - 15.248 PDW + 64.630 PDC = 23,829.226 = (-519.599 + 10.906 Y + 130.700 P - 100.0 T)

ESA - 04: QDC - 10.775 PDW - 6.857 PDR + 89.321 PDC = 20,448.720 = (1,698.163 + 8.520 Y + 117.800 P -70.0 T)

WSA - 05: QDC - 3.197 PDW + 14.385 PDC = 5,269.644 = (733.154 + 0.401 Y + 60.4 P)

ARG - 06: QDC - 2.957 PDW + 39.703 PDC = 7,769.727 = (1,354.138 + 173.2 P + 100.0 T)

UKI - 07: QDC - 10.158 PDW + 128.189 PDC = 26,189.865 = (647.523 + 7.896 Y + 238.2 P)

EEC - 08: QDC - 79.500 PDW + 234.842 PDC = 76,910.809 = (-10,745.859 + 29.350 Y + 236.8 P)

OWE - 09: QDC - 43.323 PDW + 183.555 PDC = 45,426.161 = (4,980.536 + 13.420 Y + 284.1 P)

EEU - 10: QDC - 39.426 PDW + 156.544 PDC = 64,051.203 = (5,318.265 + 6.318 Y + 365.3 P)

SUN - 11: QDC - 120.635 PDW + 256.350 PDC = 87,413.827 = (-5,119.800 + 16.140 Y + 222.3 P + 120.0 T)

NAF - 12: QDC - 3.089 PDW - 0.282 PDR + 24.946 PDC = 13,584.414 = (-1,683.598+18.426Y+86.900 P + 65.0T)

WAF - 13: QDC - 1.164 PDW - 0.614 PDR + 21.065 PDC = 18,800.466 = (-218.004 + 20.292 Y + 83.4 P)

EAF - 14: QDC - 1.285 PDW - 0.678 PDR + 34.880 PDC = 21,080.553 = (-2,684.915 + 50.342 Y + 143.8 P)

SAF - 15: QDC + 30.973 PDC = 9,001.562 = (1,162.042 + 1.738 Y + 260.0 P)

WAS - 16: QDC - 8.767 PDW - 0.244 PDR + 21.918 PDC = 14,581.834 = (-729.092 + 5.000 Y + 99.8 P)

SAS - 17: QDC - 0.700 QSC - 10.948 PDW = 7.542 PDR + 54.302 PDC = 16,639.062 = (-30.525+27.151Y+42.6P)

SEA - 18: QDC - 0.652 PDR + 1.438 PDC = 1,992.933 = (98.482 + 0.899 Y + 0.400 P + 115.0 T)

CAS - 19: QDC + 62.457 PDC = 71,480.293 = (4,666.224 + 58.900 P + 225 T)

JAP - 20: QDC + 106.529PDC = 30,388.508 = (1,493.755 + 10.473 Y + 76.100 P + 330.0 T)

EAP - 21: QDC - 2.000 PDW - 7.314 PDR + 30.004 PDC = 16,478.163 = (-2,026.629+19.152Y+34.000P+325.0 T)

ANZ - 22: QDC + 3.644 PDC = 3,769.247 = (237.100 + 169.200 P + 30.0 T)

Supply price equations - wheat

USA - 01: PSW - 0.6 PWW = 16.240

CAN - 02: PSW - PWW = -0.650

CAM - 03: PSW - 0.9 PWW = -17.770

ESA - 04: PSW - 0.4 PWW = 67.320

WSA - 05: PSW - 0.5 PWW = 33.300

ARG - 06: PSW - PWW = -6.600

UKI - 07: PSW - 0.3 PWW = 51.013 + 0.700 T = 61.513

EEC - 08: PSW - PWW = -12.340

OWE - 09: PSW - 0.5 PWW = 54.360 - 1.250 T = 35.610

EEU - 10: PSW - 0.3 PWW = 41.000

SUN - 11: PSW - 0.3 PWW = 39.730

NAF - 12: PSW - 0.5 PWW = 36.720

WAF - 13: PSW - 0.5 PWW = 30.000

EAF - 14: PSW - 0.5 PWW = 29.960

SAF - 15: PSW - 0.7 PWW = 18.000

WAS - 16: PSW - 0.7 PWW = 14.200

SAS - 17: PSW - 0.5 PWW = 42.715

SEA - 18: PSW - 0.5 PWW = 37.500

CAS - 19: PSW - 0.3 PWW = 77.500

JAP - 20: PSW - 0.3 PWW = 86.910

EAP - 21: PSW - 0.3 PWW = 77.500

ANZ - 22: PSW - PWW = -4.400

Supply-price equations - rice

USA - 01: PSR - 0.6 PWR = 23.932

CAM - 03: PSR - 0.5 PWR = 23.200

ESA - 04: PSR - 0.5 PWR = 31.850

WSA - 05: PSR - 0.5 PWR = 55.200

ARG - 06: PSR - 0.8 PWR = 5.040

EEC - 08: PSR - PWR = -65.000

OWE - 09: PSR - 0.5 PWR = 35.500

EEU - 10: PSR - 0.3 PWR = 95.500

SUN - 11: PSR - 0.3 PWR = 99.000

NAF - 12: PSR - 0.6 PWR = 37.002

WAF - 13: PSR - 0.5 PWR = 22.500

EAF - 14: PSR - 0.5 PWR = 22.500

SAF - 15: PSR - PWR = -48.000

WAS - 16: PSR - 0.6 PWR = 91.000

SAS - 17: PSR - 0.5 PWR = 27.615

SEA - 18: PSR - 1.0 PWR = -5.330

CAS - 19: PSR - 0.3 PWR = 90.000

JAP - 20: PSR - PWR = 14.100

EAP - 21: PSR - 0.5 PWR = 29.665

ANZ - 22: PSR - 0.6 PWR = 7.00

Supply-price equations - coarse grains

USA - 01: PSC - 0.6 PWC = 16.932

CAN - 02: PSC - 05. PWC = 29.855

CAM - 03: PSC - 0.5 PWC = 35.100

ESA - 04: PSC - 0.5 PWC = 11.900

WSA - 05: PSC - 0.5 PWC = 26.300

ARG - 06: PSC - 0.8 PWC = 5.52

UKI - 07: PSC - 0.3 PWC = 35.337 + 0.7 T = 45.837

EEC - 08: PSC - PWC = 2.190 + 0.5 T = 9.690

OWE - 09: PSC - 0.5 PWC = 32.335

EEU - 10: PSC - 0.3 PWC = 50.000

SUN - 11: PSC - 0.3 PWC = 38.400

NAF - 12: PSC - 0.4 PWC = 28.470

WAF - 13: PSC - 0.5 PWC = 40.000

EAF - 14: PSC - 0.7 PWC = 5.400

SAF - 15: PSC - 0.7 PWC = 6.500

WAS - 16: PSC - 0.5 PWC = 24.665

SAS - 17: PSC - 0.5 PWC = 43.500

SEA - 18: PSC - 0.8 PWC = -1.000

CAS - 19: PSC - 0.3 PWC = 35.600

JAP - 20: PSC - 0.2 PWC = 62.000

EAP - 21: PSC - 0.5 PWC = 21.000

ANZ - 22: PSC - 0.6 PWC = 10.000

Demand-price equations - wheat

USA - 01: PDW - PWW = 127.650

CAN - 02: PDW - PWW = 0

CAM - 03: PDW - 0.8 PWW = 21.160

ESA - 04: PDW - 0.7 PWW = 45.360

WSA - 05: PDW - 0.7 PWW = 38.620

ARG - 06: PDW - 0.7 PWW = 30.810

UKI - 07: PDW - PWW = 0.710

EEC - 08: PDW - PWW = 0.200

OWE - 09: PDW - PWW = 0.500

EEU - 10: PDW - 0.6 PWW = 42.000

SUN - 11: PDW - 0.5 PWW = 47.500

NAF - 12: PDW - 0.7 PWW = 35.000

WAF - 13: PDW - 0.7 PWW = 32.000

EAF - 14: PDW - PWW = 5.000

SAF - 15: PDW - PWW = 6.000

WAS - 16: PDW - 0.8 PWW = 24.800

SAS - 17: PDW - 0.8 PWW = 32.344

SEA - 18: PDW - PWW = 20.000

CAS - 19: PDW - 0.3 PWW = 97.500

JAP - 20: PDW - PWW = 20.000

EAP - 21: PDW - PWW = 10.000

ANZ - 22: PDW - PWW = 0

Demand-price equations - rice

USA - 01: PDR - PWR = 222.800

CAN - 02: PDR - PWR = 210.000

CAM - 03: PDR - PWR = 46.600

ESA - 04: PDR - PWR = 65.900

WSA - 05: PDR - PWR = 14.900

ARG - 06: PDR - 0.7 PWR = 111.910

UKI - 07: PDR - PWR = 125.000

EEC - 08: PDR - PWR = 125.000

OWE - 09: PDR - PWR = 125.000

EEU - 10: PDR - 0.7 PWR = 184.500

SUN - 11: PDR - 0.7 PWR = 186.000

NAF - 12: PDR - 0.8 PWR = 139.336

WAF - 13: PDR - 0.7 PWR = 85.500

EAF - 14: PDR - 0.8 PWR = 72.000

SAF - 15: PDR - PWR = 42.000

WAS - 16: PDR - PWR = 95.000

SAS - 17: PDR - 0.8 PWR = 69.864

SEA - 18: PDR - 1.0 PWR = 15.678

CAS - 19: PDR - 0.3 PWR = 115.000

JAP - 20: PDR - PWR = -17.000

EAP - 21: PDR - 0.8 PWR = 111.464

ANZ - 22: PDR - PWR = 20.000

Demand-price equations - coarse grains

USA - 01: PDC - PWC = 0.820

CAN - 02: PDC - PWC = 0.670

CAM - 03: PDC - 0.7 PWC = 24.720

ESA - 04: PDC - 0.8 PWC = 8.240

WSA - 05: PDC - 0.8 PWC = 16.160

ARG - 06: PDC - 0.8 PWC = 8.520

UKI - 07: PDC - PWC = 0.690 + 1.00 T = 15.690

EEC - 08: PDC - PWC = 8.630 + 0.90 T = 22.130

OWE - 09: PDC - PWC = 6.150

EEC - 10: PDC - 0.5 PWC = 45.000

SUN - 11: PDC - 0.5 PWC = 44.000

NAF - 12: PDC - 0.6 PWC = 37.200

WAF - 13: PDC - 0.7 PWC = 35.000

EAF - 14: PDC - 0.5 PWC = 41.000

SAF - 15: PDC - 0.7 PWC = 21.500

WAS - 16: PDC - 0.8 PWC = 20.264

SAS - 17: PDC - 0.8 PWC = 17.600

SEA - 18: PDC - 0.8 PWC = 17.000

CAS - 19: PDC - 0.3 PWC = 54.600

JAP - 20: PDC - 0.5 PWC = 60.000 + 1.00 T = 75.000

EAP - 21: PDC - 0.8 PWC = 34.000

ANZ - 22: PDC - PWC = 10.000

Wholesale price equations - wheat

USA - 01: PWW - 0.4 PTW = 36.302

CAN - 02: PWW - 0.8 PTW = 18.520

CAM - 03: PWW - 0.6 PTW = 60.300

ESA - 04: PWW - 0.3 PTW = 63.240

WSA - 05: PWW - 0.3 PTW = 51.200

ARG - 06: PWW - PTW = -10.570

UKI - 07: PWW - PTW = -10.140

EEC - 08: PWW - 0.3 PTW = 88.626

OWE - 09: PWW - 0.5 PTW = 78.690

EEU - 10: PWW - 0.1 PTW = 73.050

SUN - 11: PWW - 0.3 PTW = 68.700

NAF - 12: PWW - 0.3 PTW = 77.950

WAF - 13: PWW - 0.2 PTW = 75.000

EAF - 14: PWW - 0.3 PTW = 68.409

SAF - 15: PWW - 0.5 PTW = 70.750

WAS - 16: PWW - 0.5 PTW = 56.750

SAS - 17: PWW - 0.4 PTW = 84.154

SEA - 18: PWW - 0.6 PTW = 58.500

CAS - 19: PWW - 0.1 PTW = 117.359

JAP - 20: PWW - 0.9 PTW = 84.687

EAP - 21: PWW - 0.8 PTW = 63.480

ANZ - 22: PWW - 0.8 PTW = 2.944

Wholesale price equations - rice

USA - 01: PWR - 0.4 PTR = 128.330

CAN - 02: PWR - PTR = 31.500

CAM - 03: PWR - 0.4 PTR = 159.060

ESA - 04: PWR - 0.5 PTR = 24.550

WSA - 05: PWR - 0.5 PTR = 132.050

ARG - 06: PWR - 0.5 PTR = -5.85

UKI - 07: PWR - PTR = 69.000

EEC - 08: PWR - 0.5 PTR = 137.965

OWE - 09: PWR - PTR = 47.350

EEU - 10: PWR - 0.8 PTR = 86.640

SUN - 11: PWR - 0.8 PTR = 91.360

NAF - 12: PWR - 0.8 PTR = -8.270

WAF - 13: PWR - 0.2 PTR = 102.700

EAF - 14: PWR - 0.2 PTR = 103.678

SAF - 15: PWR - PTR = 6.040

WAS - 16: PWR - 0.8 PTR = 139.712

SAS - 17: PWR - 0.2 PTR = 106.906

SEA - 18: PWR - 0.5 PTR = -2.20

CAS - 19: PWR - 0.1 PTR = 135.039

JAP - 20: PWR - 0.2 PTR = 288.958

EAP - 21: PWR - 0.7 PTR = 55.208

ANZ - 22: PWR - PTR = -11.060

Wholesale price equations - coarse grains

USA - 01: PWC - 0.8 PTC = 6.140

CAN - 02: PWC - PTC = -2.170

CAM - 03: PWC - 0.5 PTC = 48.95

ESA - 04: PWC - 0.7 PTC = 1.430

WSA - 05: PWC - 0.4 PTC = 54.480

ARG - 06: PWC - 0.8 PTC - 4.14

UKI - 07: PWC - PTC = 5.48

EEC - 08: PWC - 0.3 PTC = 64.106

OWE - 09: PWC - 0.5 PTC = 55.870

EEU - 10: PWC - 0.1 PTC = 73.270

SUN - 11: PWC - 0.1 PTC = 65.830

NAF - 12: PWC - 0.3 PTC = 48.020

WAF - 13: PWC - 0.2 PTC = 87.080

EAF - 14: PWC - 0.8 PTC = 13.120

SAF - 15: PWC - PTC = -0.100

WAS - 16: PWC - 0.5 PTC = 41.045

SAS - 17: PWC - 0.2 PTC = 89.080

SEA - 18: PWC - 0.8 PTC = 13.760

CAS - 19: PWC - 0.1 PTC = 61.150

JAP - 20: PWC - PTC = 23.400

EAP - 21: PWC - 0.5 PTC = 36.650

ANZ - 22: PWC - 0.8 PTC = 12.120

Stock Equations

USA - 01: DSW + 250.0 PTW = 16,892.5

CAN - 02: DSW - 0.750 QSW + 425.0 PWW = 17,272.5

ANZ - 22: DSW - 0.500 QSW + 100.0 PWW = 400.0

USA - 01: DSR - QSR + QDR + ER = 0

USA - 01: DSC + 100.0 PTC = 6,230.0

Defining wheat AID Demand in USA for SAS:

DAWUSA = 2,000.0

ADWSAS = 2,000.0

Feed Wheat Demand:

USA - 01: QDFW - 1.5 DSW = 0

CAN - 02: QDFW - 0.3 DSW = 0

EEC - 08: QDFW + 200.0 PTW = 12,916

General note: In the system all exports, all stocks and feed demands for wheat are unbounded, that is the quantities can be either negative or positive to assure a feasible solution when solving the model under different assumptions.

World equilibrium conditions

QSW USA + QSW CAN + QSW CAM +...+QSW ANZ - QDW USA - QDW CAN - QDW CAM-...- QDW ANZ

- DSW USA - DSW CAN - DSW ANZ - DAW USA + 0.3 QDW SAS - QDFW USA - QDFW CAN - QDFW EEC = 0

QSR USA + QSR CAM + QSR EAS +...+ QSR ANZ - QDR USA - QDR CAN - QDR CAM -...- QDR ANZ

- DSR USA = 0

QSC USA + QSC CAN + QSC CAM +...+QSC ANZ - QDC USA - QDC CAN - QDC CAM -...-QDC ANZ - DSC USA

+ QDFW USA + QQFW CAN + QDFW EEC = 0

Interregional Price Relationships (Model I)
(Export and Import prices)

Wheat

USA - 01: PTWUSA - PTWCAM = -6.43

CAN - 02: PTWCAN - PTWUKI = 10.08

CAM - 03: PTWCAM - PTWUSA = 6.43

ESA - 04: PTWESA - PTWUSA = 9.63

WSA - 05: PTWWSA - PTWUSA = 10.43

ARG - 06: PTWARG - PTWUKI = -13.36

UKI - 07: PTWUKI - PTWUSA = 9.86

EEC - 08: PTWEEC - PTWNAF = -8.92

OWE - 09: PTWOWE - PTWUSA = 8.05

EEU - 10: PTWEEU - PTWARG = 9.43

SUN - 11: PTWSUN - PTWEEU = -6.50

NAF - 12: PTWNAF - PTWUSA = 9.93

WAF - 13: PTWWAF - PTWUSA = 11.43

EAF - 14: PTWEAF - PTWANZ = 8.15

SAF - 15: PTWSAF - PTWARG = 6.43

WAS - 16: PTWWAS - PTWUSA = 10.93

SAS - 17: PTWSAS - PTWUSA = 12.47

SEA - 18: PTWSEA - PTWUSA = 13.93

CAS - 19: PTWCAS - PTWCAN = 13.06

JAP - 20: PTWJAP - PTWUSA = 9.00

EAP - 21: PTWEAP - PTWUSA = 13.33

ANZ - 22: PTWANZ - PTWJAP = -8.75

USA - 01: PTRUSA - PTRCAN = -11.00

CAN - 02: PTRCAN - PTRUSA = 11.00

CAM - 03: PTRCAM - PTRESA = 11.75

EAS - 04: PTRESA - PTRWSA = 9.60

WSA - 05: PTRWSA - PTRUSA = 11.20

ARG - 06: PTRARG - PTRWSA = -9.60

UKI - 07: PTRUKI - PTRUSA = 8.50

EEC - 08: PTREEC - PTRUSA = 6.57

OWE - 09: PTROWE - PTRUSA = 10.15

EEU - 10: PTREEU - PTRESA = 11.35

SUN - 11: PTRSUN - PTRESA = 11.70

NAF - 12: PTRNAF - PTRSUN = -8.80

WAS - 13: PTRWAF - PTRUSA = 14.00

EAF - 14: PTREAF - PTRSEA = 11.55

SAF - 15: PTRSAF - PTRSEA = 11.90

WAS - 16: PTRWAS - PTRSEA = 11.55

SAS - 17: PTRSAS - PTRSEA = 8.76

SEA - 18: PTRSEA - PTREEC = -9.01

CAS - 19: PTRCAS - PTRJAP = 5.60

JAP - 20: PTRJAP - PTRSEA = 10.15

EAP - 21: PTREAP = PTRSEA = 5.60

ANZ - 22: PTRANZ - PTREAP = -9.60

Coarse grains

USA - 01: PTCUSA - PTCCAM = -6.60

CAN - 02: PTCCAN - PTCUKI = -8.33

CAM - 03: PTCCAM - PTCUSA = 6.60

ESA - 04: PTCESA - PTCWSA = -12.20

WSA - 05: PTCWSA - PTCARG = 10.50

ARG - 06: PTCARG - PTCWAS = -10.50

UKI - 07: PTCUKI - PTCUSA = 8.53

EEC - 08: PTCEEC - PTCUSA = 6.48

OWE - 09: PTCOWE - PTCUSA = 9.66

EEU - 10: PTCEEU - PTCSUN = 6.10

SUN - 11: PTCSUN - PTCOWE = 4.65

NAF - 12: PTCNAF - PTCUSA = 10.30

WAF - 13: PTCWAF - PTCSAF = 9.50

EAF - 14: PTCEAF - PTCWAS = 11.15

SAF - 15: PTCSAF - PTCUKI = -9.73

WAS - 16: PTCWAS - PTCUSA = 10.95

SAS - 17: PTCSAS - PTCUSA = 13.30

SEA - 18: PTCSEA - PTCJAP = -8.80

JAP - 20: PTCJAP - PTCCAN = 10.30

EAP - 21: PTCEAP - PTCSEA = 8.90

ANZ - 22: PTCANZ - PTCJAP = -13.00

Interregional Price Relationships (Model II)
(Export and Import prices)

$$PT_{ij} - PB_i - RP_{ij} = 0$$

Note: Since these equations have the same form for all regions and commodities, only their general form is given here. The variables PT_{ij} and PB_i are determined with the system. The variables RP_{ij} (simplex multipliers) are duals of the primal solution of the transportation matrix of the system.

Objective Function (Model II)

$$\text{Min.}Z = \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{n} TC_{ijk} \cdot QT_{ijk}$$

Note: TC_{ijk}, transportation costs of commodity i from region j to region k, are given in table A1. The cost for heavy grains apply to all three categories of grain in the model.

Transportation Matrix Equations (Model II)

The general form of this set of equations is:

$$QS_{ij} - \sum_{i=1}^{n} QT_{ijk} = 0 \text{ and}$$

$$QD_{ik} - \sum_{i=1}^{n} QT_{ijk} = 0.$$

Where QS_{ij}, the quantity supplied of commodity i in region j = the sum of quantities shipped (exported) of commodity i from region j to regions k (k = 1,2,3,...,22), including shipment of region j to itself to satisfy its own demand;

and QD_{ik}, the quantity demanded of commodity i in region k = the sum of quantities shipped (imported) of commodity i from regions j (j = 1,2,3,...,22) to region k, including shipment of region k to itself.

Some equations in the Transportation Matrix have been adjusted to include institutional factors and policy considerations. These are:

$$\text{USA - 01:} \quad QSW - \sum_{i=1}^{n} QTWjk - DSW - DAW - QDFW = 0$$

$$\text{CAN - 02:} \quad QSW - \sum_{i=1}^{n} QTWjk - DSW - QDFW = 0$$

$$\text{EEC - 08:} \quad QSW - \sum_{i=1}^{n} QTWjk - QDFW = 0$$

$$\text{ANZ - 22:} \quad QSW - \sum_{i=1}^{n} QTWjk - DSW = 0$$

$$\text{USA - 01:} \quad QSR - \sum_{i=1}^{n} QTRjk - DSR = 0$$

$$\text{USA - 01:} \quad QSC - \sum_{i=1}^{n} QTCjk - DSC = 0$$

$$\text{SAS - 17:} \quad QDW - \sum_{i=1}^{n} QTWjk - 0.3\ ADW = 0$$

$$\text{USA - 01:} \quad QDC - \sum_{i=1}^{n} QTCjk - QDFW = 0$$

$$\text{CAN - 02:} \quad QDC - \sum_{i=1}^{n} QTCjk - QDFW = 0$$

$$\text{EEC - 08:} \quad QDC - \sum_{i=1}^{n} QTCjk - QDFW = 0$$

Equations Reflecting Institutional and Policy Factors

Defining Total Exports (Model I)

$$TEW - \sum_{j=1}^{n} QSW_j + \sum_{k=1}^{n} QDW_k + DSWUSA + DSWCAN + DSWANZ + QDFWUSA + QDFWCAN + QDFWEEC = 0$$

$$TER - \sum_{j=1}^{n} QSR_j + \sum_{k=1}^{n} QDR_k + DSRUSA = 0$$

$$TEC - \sum_{j=1}^{n} QSC_j + \sum_{k=1}^{n} QDC_k + DSCUSA - QDFWUSA - QDFWCAN - QDFWEEC = 0$$

Defining Total Exports (Model II)

$$TEW - \sum_{j=1}^{n} QSW_j + \sum_{j=1}^{n} QTW_{jj} + DSWUSA + DSWCAN + DSWANZ + QDFWUSA + QDFWCAN + QDFWEEC = 0$$

$$TER - \sum_{j=1}^{n} QSR_j + \sum_{j=1}^{n} QTR_{jj} + DSRUSA = 0$$

$$TEC - \sum_{j=1}^{n} QSC_j + \sum_{j=1}^{n} QTC_{jj} + DSCUSA - QDFWUSA - QDFWCAN - QDFWEEC = 0$$

General Export Equations

USA - 01 $EW - OSW + QDW + DSW + QDFW = 0$

$$EW - \sum_{j=2}^{n-1} QTW = 0 \quad \text{(Model II only)}$$

CAN - 02 $EW - QSW + QDW + DWS + QDFW = 0$

$$EW - \sum_{j=2}^{n-1} QTW = 0 \quad \text{(Model II only)}$$

EEC - 08 $EW - QSW + QDW + QDFW = 0$

ANZ - 22 $EW - QSW + QDW + DSW = 0$

$$EW - \sum_{j=2}^{n-1} QTW = 0 \quad \text{(Model II only)}$$

USA - 01 $ER - 0.40\ PTR - 0.1\ TER = -3650.0$

$$ER - \sum_{j=2}^{n-1} QTR = 0 \quad \text{(Model II only)}$$

USA - 01 $EC - QSC + QDC + DSC - QDFW = 0$

$$EC - \sum_{j=2}^{n-1} QTC = 0 \quad \text{(Model II only)}$$

CAN - 02 $EC - QSC + QDC - QDFW = 0$

Specific Regional Trade Preferences

USA to UKI	QTW0107 + 0.10 QSWUKI - 0.10 QDWUKI $\geq$ 0
USA to SAS	QTW0117 + 0.30 QSWSAS - 0.30 QDWSAS $\geq$ 0
CAN to SAS	QTW0217 + 0.30 QSWSAS - 0.30 QDWSAS $\geq$ 0
CAN to JAP	QTW0220 + 0.30 QSWJAP - 0.30 QDWJAP = 0
ARG to WSA	QTW0605 + 0.20 QSWWSA - 0.20 QDWWSA $\geq$ 0
ARG to UKI	QTW0607 + 0.20 QSWUKI - 0.20 QDWUKI = 0
SUN to EEU	QTW1110 + 0.40 QSWEEU - 0.40 QDWEEU $\geq$ 0
SUN to WAS	QTW1116 - 0.20 QSWWAS + 0.20 QDWWAS = 0
ANZ to JAP	QTW2220 + 0.10 QSWJAP - 0.10 QDWJAP $\geq$ 0
SEA to UKI	QTR1807 - 0.15 QDRUKI = 0
SEA to EEC	QTR1808 + 0.25 QSREEC - 0.25 QDREEC = 0
SEA to EEU	QTR1810 + 0.30 QSREEU - 0.30 QDREEU = 0
USA to UKI	QTC0107 + 0.50 QSCUKI - 0.50 QDCUKI $\geq$ 0
USA to SAS	QTC0117 + 0.50 QSCSAS - 0.50 QDCSAS $\geq$ 0
ARG to EEC	QTC0608 + 0.15 QSCEEC - 0.15 QDCEEC = 0
SEA to JAP	QTC1820 - 0.50 QSCSEA + 0.50 QDCSEA $\geq$ 0
ANZ to JAP	QTC2220 - 0.40 QSCANZ + 0.40 QDCANZ $\geq$ 0

Note: These equations constrain the transportation matrix in the system in the sense that they force a certain percent of demand for a given grain in a region to be satisfied from exports of a specific region. This assumes that the exporters involved will try to maintain a share in the specific markets irrespective of price considerations.

Table A-1.--Ocean Freight Rates for Heavy Grains in Voyage Chartered Foreign Flag Vessels. 1/
(Dollars per metric ton)

Origin \ Destination	01 USA	02 CAN	03 CAM	04 ESA	05 WSA	06 ARG	07 UKI	08 EEC	09 OWE	10 EEU	11 SUN	12 NAF	13 WAF	14 EAF	15 SAF	16 WAS	17 SAS	18 SEA	19 CAS	20 JAP	21 EAP	22 ANZ
01 United States 2/	0	4.10	4.40	7.60	8.00	8.00	8.50	4.15	7.25	5.75	7.60	8.00	10.00	12.00	9.00	10.60	12.25	14.00	11.00	8.90	12.00	8.50
02 Canada 3/	4.10	0	6.25	8.15	8.10	8.50	5.50	4.50	7.25	6.00	7.75	9.00	10.50	12.00*	9.80	13.25*	12.25	14.00	11.00	9.90	12.00	8.50
03 Central America 4/	4.40	6.25	0	8.40	4.40	8.00	7.80	5.00	6.00	5.75	7.75	7.25	7.50	11.00	8.25	13.75	13.90	13.00	11.50	10.50	12.00	9.25
04 East South America (Rio)	7.60	8.15	8.40	0	7.00	5.00	11.25	7.60	8.35	8.10	8.35	8.10	8.75	9.10	6.10	13.60	13.90	14.60	13.10	13.60	11.60	8.00
05 West South America (Callao)	8.00	8.10	4.40	7.00	0	7.00	10.90	10.00	10.25	10.10	10.25	9.50	10.90	11.50	10.50	14.25	14.00	10.00	9.50	9.25	9.75	7.90
06 Argentina (Buenos Aires)	8.00	8.50	8.00	5.00	7.00	0	11.25	7.50	8.25	8.00	8.25	8.00	8.65	9.00	6.00	13.50	13.80	14.50	13.00	13.50	11.50	9.50
07 United Kingdom (Liverpool)	8.50	5.50	7.80	11.25	10.90	11.25	0	5.70	6.00	5.75	6.25	6.10	7.00	7.25*	6.90	9.00*	9.15*	10.25*	11.25*	11.00*	10.00*	10.80*
08 E.E.C. (Amsterdam)	4.15	4.50	5.00	7.60	10.00	7.50	5.70	0	5.00	4.00	6.25	6.60	7.40	7.50	7.25*	9.25*	9.40*	9.25*	10.25*	9.75*	9.00*	7.50*
09 Other West Europe (Barcelona)	7.25	7.25	6.00	8.35	10.25	8.25	6.00	5.00	0	6.50	4.25	3.75	8.25	9.00*	8.50	10.75*	10.50*	11.50*	12.50*	12.00*	11.50*	11.50*
10 Eastern Europe (Danzig)	5.75	6.00	5.75	8.10	10.10	8.00	5.75	4.00	6.50	0	5.40	3.62	8.65	12.00*	8.84	13.00*	13.25*	14.75*	15.00*	14.25*	13.75*	12.25*
11 Soviet Union (Odessa)	7.60	7.75	7.75	8.35	10.25	8.25	6.25	6.25	4.25	6.50	0	3.00	9.57	12.25*	9.41	13.25*	13.50	15.00*	15.00*	14.50*	14.00*	12.75*
12 North Africa 5/	8.00	9.00	7.25	8.10	9.50	8.00	6.70	6.60	3.75	7.25	4.25	0	7.84	10.00*	7.67	13.00*	14.00*	15.00	15.00*	15.00*	14.00*	12.00*
13 West Africa (Lagos)	10.00	10.50	7.50	8.75	10.90	8.65	7.00	7.40	8.25	9.25	9.75	8.25	0	6.90	6.50	8.60	8.50	9.00	9.50	9.35	8.75	8.75
14 East Africa (Mombassa)	12.00	12.00*	11.00	9.10	11.50	9.00	7.25*	7.50*	9.00*	10.50*	11.00*	9.00*	6.90	0	6.50	6.75	8.00	8.25	8.65	8.70	8.00	8.60
15 South Africa (Capetown)	9.00	9.80	8.25	6.10	10.50	6.00	6.90	7.25	8.50	9.75	10.25	8.50	6.50	6.50	0	8.50	8.35	8.50	8.60	8.75	8.40	8.40
16 West Asia (Basra)	13.25	13.25*	13.75	13.60	14.25	13.50	9.00*	9.25*	10.75*	11.75*	12.25*	10.75*	8.60	6.75	8.50	0	7.50	8.25	8.50	8.90	8.00	9.00
17 South Asia 6/	12.25	12.25	13.90	13.90	14.00	13.80	9.15*	9.40*	10.50	11.50*	12.00	10.50*	8.50	8.00	8.35	7.50	0	6.25	8.00	8.25	6.00	8.40
18 South East Asia (Bangkok)	14.00	14.00	13.00	14.60	10.00	14.50	8.00*	9.25*	11.50*	12.25*	12.25*	11.50*	9.00	8.25	8.50	8.25	6.25	0	6.75	7.25	4.00	7.75
19 Communist Asia (Shanghai)	11.00	11.00	11.50	13.10	9.50	13.00	8.25*	10.25*	12.50*	13.00*	13.00*	12.50*	9.50	8.65	8.60	8.50	8.00	6.75	0	4.00	6.75	7.75
20 Japan (Yokohama)	8.90	9.90	10.50	13.60	9.25	13.50	8.25*	9.75*	12.00*	12.50*	12.50*	12.00*	9.35	8.70	8.75	8.90	8.25	7.25	4.00	0	6.50	7.50
21 East Asia & Pacific (Singapore)	12.00	12.00	12.00	11.60	9.75	11.50	8.15*	9.00*	11.50*	12.25*	12.00*	11.50*	8.75	8.00	8.40	8.00	6.00	4.00	6.75	6.50	0	7.00
22 Australia & New Zealand (Melbourne)	9.10	9.10	9.85	8.00	7.90	9.50	10.80*	7.50*	11.50*	12.00*	12.00*	11.40*	8.75	8.60	8.40	9.00	8.40	7.75	7.75	7.50	7.00	0

1/ All rates are on the "free out" basis, i.e., cost of discharge not included. 2/ Rates to and from the United States are based on the average distance from Seattle, Galveston, Baltimore and Toledo. However, when the normal trade routes are known, then only those distances were averaged. 3/ Rates from and to Canada are based on the distance from and to Montreal and Vancouver. To compensate for shipments from the Great Lakes, 300 miles were added to the Montreal distance. Only the Vancouver rates were used for Far East shipments. 4/ Rates from and to Veracruz and Manzanillo, Mexico. 5/ Average rates from and to Casablanca, Tunis and Alexandria. 6/ Average rates from and to Bombay and Calcutta.

* Indicates rates via Cape of Good Hope.

Source: Ocean Transportation Division, Export Marketing Service, Economic Research Service, U.S. Department of Agriculture. Some freights have been adjusted for policy factors by the Foreign Regional Analysis Division,

Table A-2.--Wheat: Export and import prices, 1964-66 average, and projections to 1980 under alternative projection sets 1/

Region	1964-66	Projections to 1980				
		Set I	Set II	Set III	Set II-A	Set II-B
	Dollars per metric ton					
Developed:						
United States	63.57	61.92	54.97	66.84	22.23	37.60
Canada	63.35	65.75	58.12	70.80	22.01	37.38
EC	64.58	63.32	56.37	68.24	23.24	38.61
United Kingdom	73.42	67.06	59.92	71.79	32.09	47.46
Other W. Europe	71.62	66.16	59.22	71.09	30.28	45.65
Japan	72.57	70.82	63.87	75.74	31.23	46.60
Australia & New Zealand	63.82	59.12	51.41	63.42	22.48	37.85
South Africa, Rep. of	66.50	70.52	63.57	75.44	25.16	40.53
Central plan:						
Eastern Europe	69.50	67.32	60.37	72.24	28.16	43.53
USSR	63.00	66.92	59.97	71.84	21.66	37.03
Communist Asia	76.41	72.56	64.12	77.29	35.07	50.44
Less developed:						
Cent. Am. & Mexico	70.00	66.32	59.37	71.24	28.66	44.03
Argentina	60.07	60.94	54.22	65.70	18.73	34.10
East South America	73.20	69.52	62.57	74.44	31.86	47.23
West South America	74.00	69.66	62.52	74.39	32.66	48.03
East Africa	71.97	70.82	63.87	75.74	30.63	46.00
West Africa	75.00	70.72	63.77	75.64	33.66	49.03
North Africa	73.50	69.92	62.97	74.84	32.16	47.53
West Asia	74.50	72.52	63.62	77.44	33.16	48.53
South Asia	76.04	72.72	56.12	77.64	34.70	50.07
Southeast Asia	77.50	72.56	62.37	77.29	36.16	51.53
East Asia & Pac. Is.	76.90	71.82	62.12	76.54	35.56	50.93

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in Set I. Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in Set I.

Table A-3.--Rice: Export and import prices, 1964-66 average, and projections to 1980 under alternative projection sets 1/

Region	1964-66	Projections to 1980				
		Set I	Set II	Set III	Set II-A	Set II-B
	Dollars per metric ton					
Developed:						
United States	147.50	118.38	72.32	138.53	66.63	70.13
Canada	158.50	122.48	78.57	142.63	77.63	81.13
EC	154.07	122.53	77.70	142.68	73.20	76.70
United Kingdom	156.00	126.88	76.55	147.03	75.13	78.63
Other W. Europe	157.65	124.29	76.32	144.44	76.78	80.28
Japan	155.21	124.48	72.30	145.88	74.34	77.84
Australia & New Zealand	141.06	120.16	73.82	141.46	60.19	63.69
South Africa, Rep. of	156.96	126.13	76.90	147.53	76.09	79.59
Central plan:						
Eastern Europe	160.45	126.90	78.07	147.15	79.58	83.08
USSR	160.80	124.79	76.82	144.94	79.93	83.43
Communist Asia	149.61	120.11	71.92	141.41	68.74	72.24
Less developed:						
Cent. Am. & Mexico	160.85	122.78	78.57	142.93	79.98	83.48
Argentina	149.10	119.76	74.52	141.06	68.23	71.73
East South America	149.10	119.66	74.42	146.13	68.23	71.73
West South America	158.70	126.38	77.80	146.53	77.83	81.33
East Africa	156.61	129.13	76.80	150.52	75.74	79.24
West Africa	161.50	128.38	77.55	148.52	80.63	84.13
North Africa	152.00	120.17	76.20	140.22	71.13	74.63
West Asia	156.61	128.98	76.80	149.12	75.74	79.24
South Asia	153.82	128.48	74.80	149.87	72.95	76.45
Southeast Asia	145.06	121.86	72.17	143.16	64.19	67.69
East Asia & Pac. Is.	150.66	126.23	72.55	147.63	69.79	73.29

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in Set I. Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in Set I.

Table A-4.--Coarse grains: Export and import prices, 1964-66 average, and projections to 1980 under alternative projection sets 1/

Region	1964-66	Projections to 1980				
		Set I	Set II	Set III	Set II-A	Set II-B
	Dollars per metric ton					
Developed:						
United States	56.30	55.32	45.97	61.56	23.64	34.50
Canada	56.50	55.32	46.37	61.56	23.84	34.70
EC	62.78	59.47	50.12	65.71	30.12	40.98
United Kingdom	64.83	60.82	51.87	67.06	32.17	43.03
Other W. Europe	65.96	62.57	50.87	68.81	33.30	44.16
Japan	66.60	64.22	54.87	70.46	33.94	44.80
Australia & New Zealand	53.60	58.82	47.37	66.56	20.94	31.80
South Africa, Rep. of	55.10	57.42	46.12	65.16	22.44	33.30
Central plan:						
Eastern Europe	67.30	56.07	46.12	63.94	34.64	45.50
USSR	61.20	58.32	46.62	64.56	28.54	39.40
Communist Asia	68.50	66.02	54.72	72.56	35.84	46.70
Less developed:						
Cent. Am. & Mexico	62.90	59.72	50.37	65.96	30.24	41.10
Argentina	52.80	54.32	42.62	62.56	20.14	31.00
East South America	51.10	54.22	42.52	62.56	18.44	29.30
West South America	63.30	61.22	49.52	69.56	30.64	41.50
East Africa	56.10	59.17	46.47	65.56	23.44	34.30
West Africa	64.60	62.97	51.27	71.21	31.94	42.80
North Africa	66.60	59.69	49.62	67.56	33.94	44.80
West Asia	67.25	65.92	53.22	72.16	34.59	45.45
South Asia	69.60	65.77	54.47	73.51	36.94	47.80
Southeast Asia	57.80	61.82	48.22	69.56	25.14	36.00
East Asia & Pac. Is.	66.70	65.82	52.22	73.56	34.04	44.90

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the less developed countries. Set II assumes that agricultural productivity and economic growth in the less developed countries would be higher than projected in Set I. Set II-A assumes that major developed exporters would maintain their traditional share of the world market. Set II-B assumes that the major developed importers would become more sensitive to world grain prices and adjust their high internal prices to changes in world prices. Set III assumes that agricultural productivity and economic growth in the less developed countries would be lower than projected in Set I.

APPENDIX B.--INTEGRATING A FEED-LIVESTOCK ECONOMY OF A SINGLE COUNTRY INTO A SIMPLIFIED WORLD GRAIN MODEL

This appendix shows one way in which the livestock sector may be incorporated into a derived demand for coarse grains in terms of coarse grain prices. Specifically, the purpose is to reflect the influence of livestock quantities and prices without explicitly including these variables in the demand equation for feed.

We begin with a simple livestock model:

Demand for livestock products

(1) $Q_L^d + 2P_L = 2Y$

Supply of livestock products

(2) $Q_L^s - 3P_L = -2P_G + 3T$

Equilibrium condition

(3) $Q_L = Q_L^s = Q_L^d$

Where:

Q_L^d = Quantity of livestock products demanded

Q_L^s = Quantity of livestock products supplied

P_L = Price of livestock products

Y = Income

P_G = Price of coarse grains

T = Trend variable

Q_L = Equilibrium quantity for livestock products

We assume that the prices and quantities of livestock products are endogenous, while the remaining variables are exogenous. Also, there are no imports of livestock products; this restriction will be lifted later.

In matrix form, equations (1) to (3) may be reduced to:

$$\begin{bmatrix} 1 & 2 \\ 1 & -3 \end{bmatrix} \begin{bmatrix} Q_L \\ P_L \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 \\ 0 & -2 & 3 \end{bmatrix} \begin{bmatrix} Y \\ P_G \\ T \end{bmatrix}$$

(4)
$$\begin{bmatrix} Q_L \\ P_L \end{bmatrix} = \begin{bmatrix} 1.2 & -.8 & 1.2 \\ .4 & .4 & -.6 \end{bmatrix} \begin{bmatrix} Y \\ P_G \\ T \end{bmatrix}$$

From equation set (4), we can write

(4a) $Q_L = 1.2Y - .8P_G + 1.2T$

If we are given the technical relation

(5) $$Q_G = 4Q_L$$

where Q_G refers to quantity of grain, we can substitute (5) in (4a) and recombine to obtain the following derived demand for grains in terms of feed grain prices.

Derived demand for grains

(6) $$.25Q_G^d + .8P_G = 1.2Y + 1.2T$$

Supply of grains

(7) $$Q_G^d - 2P_G = 1.5T$$

Equation (6) is in the desired form for use as a demand equation along with the supply equation (7) in the world grain model.

Now, even though the world grain model uses only grain prices, it implicitly takes into account the joint interactions due to P_L and Q_L in equations (1) and (2) by use of equation set (4). Specifically, for every Q_G^d generated by the world grain model, there is a corresponding Q_L and P_L which can be estimated by use of equation (4).

So far, we have assumed that there would be imports of grain but no imports of livestock products. One way of introducing imports of livestock products would be to assume a deliberate policy of maintaining some degree of self-sufficiency. For example, 80 percent self-sufficiency could be introduced by modifying equation (3) to

(3a) $$Q_L = Q_L^s = 0.8Q_L^d$$

If we had used parameters instead of constants for coefficients, then,

(I) $$Q_L^d + aP_L = bY$$

(II) $$Q_L^s + cP_L = dP_G + eY$$

(III) $$Q_L = Q_L^s = Q_L^d$$

In matrix form

$$\begin{bmatrix} 1 & a \\ 1 & c \end{bmatrix} \begin{bmatrix} Q_L \\ P_L \end{bmatrix} = \begin{bmatrix} b & o & o \\ o & d & e \end{bmatrix} \begin{bmatrix} Y \\ P_G \\ T \end{bmatrix}$$

$$\begin{bmatrix} Q_L \\ P_L \end{bmatrix} = \begin{bmatrix} 1 & a \\ 1 & c \end{bmatrix}^{-1} \begin{bmatrix} b & o & o \\ o & d & e \end{bmatrix} \begin{bmatrix} Y \\ P_G \\ T \end{bmatrix}$$

$$\begin{bmatrix} Q_L \\ P_L \end{bmatrix} = \frac{1}{c - a} \begin{bmatrix} c & -1 \\ -a & 1 \end{bmatrix} \begin{bmatrix} b & o & o \\ o & d & e \end{bmatrix} \begin{bmatrix} Y \\ P_G \\ T \end{bmatrix}$$

(IV) $$\begin{bmatrix} Q_L \\ P_L \end{bmatrix} = \frac{1}{c - a} \begin{bmatrix} cb & cd & ce \\ -ab & -ad & -ae \end{bmatrix} \begin{bmatrix} Y \\ P_G \\ T \end{bmatrix}$$

(IVa) $$Q_L = \frac{cb}{c - a} Y + \frac{cd}{c - a} P_G + \frac{ce}{c - a} T$$

Which is equivalent to equation (4a).

Letting equation (5) be

(V) $$Q_G = kQ_L$$

We obtain by substituting (V) into (IVa) and recombining

$$Q_G = \frac{kcd}{c - a} P_G + \frac{kcb}{c - a} Y + \frac{kce}{c - a} T$$

which is equivalent to equation (6).

APPENDIX C.—TRADE FLOWS

The emphasis in chapter VIII was on projections of 1980 grain production, consumption, and trade for each of the 22 regions. This appendix presents in more detail the trade flows between the regions.[1] These trade flows are in part subject to the condition that minimizes transfer costs among regions and in part subject to special policy constraints. The objective function and the constraints are discussed in chapters IV (p. 26) and VII (pp. 57-60). Transfer costs—that is, ocean freight rates—have been calculated on the basis of grains in bulk and are therefore the same for wheat, rice, and coarse grains (app. table A1).

Trade flows are determined for a base year and for projection sets I, II, and III. The base year solution, which is not included in this study, served only to check the reasonableness of the computer solution.[2] Actual base period flows, 1963-65 averages, are used for comparison with the flows in projection sets I and II (app. tables C-1 through C-9). The flows for projection set III are not included since they differ from set I only in the level of quantity flow.

The 1963-65 base period, rather than 1964-66 as in the rest of this report, was used because trade matrices for rice and coarse grains were readily available only for the earlier period (*89*). Regional aggregations for this base are slightly different from the ones in the projection period but this should not hamper comparisons.

As in chapter VIII (Projections of Demand, Supply, and Trade), trade flow projections in set I are compared with trade flows in the base period and the projections in set II are compared with projections in set I. It should be remembered that the basic assumptions are a continuation of current policies—including stabilization of world prices—for set I, and an acceleration of the growth rate of grain production in LDC's for set II.

[1] The projected values presented here as well as those in ch. VIII are part of the same solution sets obtained from model II. As indicated on p. 76, model II was used for projection sets I, II, and III, while model I was used in sets II-A and II-B.

[2] The initial solution involved an unconstrained transportation matrix. Consequently, the results from that solution set could be viewed as a minimum transportation cost equilibrium solution and would be similar to the "competitive" solution in many spatial equilibrium studies on marketing efficiency. Of interest is that the trade flows obtained for the base period for the "competitive" situation did not differ drastically from the trade flows in the real world. It would have been desirable to have "simulated" the model back through the historical period and then adjusted the model for projecting into the future.

When comparing the base period trade flows with the projected flows, it should also be kept in mind that the model generally but not necessarily solves for *net trade flows*. Hence, the density of the trade flow matrix in the base period, which includes gross flows, is much greater than in the projection sets.

Projection Set I

Wheat

Under projection set I, the share of world wheat exports would drop from about 87 percent in the base period to 82 percent in 1980 for the developed area; increase from 5 percent to 8 percent for the central plan area; and increase only slightly from 8 to over 9 percent for the LDC's.

The relative importance of the United States in the export market would drop from 39 percent in the base period to about 35 percent in 1980, but the marketing areas would not change substantially. Among the LDC's, the demand for U.S. wheat exports may increase in Latin America, North Africa, and West Asia; but in South Asia, which accounted for about 34 percent of U.S. exports in the base period, shipments would diminish by more than half and would only account for 11 percent of the U.S. total. On the positive side, Japanese imports would more than double.

The relative importance of Canadian wheat exports in world trade is also expected to drop from 25 percent in the base period to 22 percent in 1980. Her markets in the developed world would remain unchanged and exports to the United Kingdom and Japan could increase. Canadian wheat exports to Communist China would double by 1980, but Eastern Europe and the Soviet Union would no longer be a market. In the LDC's, Canadian exports to Latin America may treble.

The EC share of the wheat export market is not expected to change substantially from the base period, but the destination of EC exports may tend to change on account of transportation cost advantage to Eastern Europe and Africa. Australia's relative importance in world trade could increase from about 12 percent in the base period to 14 percent in 1980, with most of its exports going to the Far East countries.

The Soviet Union's share of the world wheat trade may increase under set I from about 5 percent in the base period to 8 percent in 1980. The direction of her

exports could shift from Europe to North Africa and West Asia, though Eastern Europe would still remain an important customer. Finally, Argentina would maintain her export position of nearly 10 percent of world trade as well as her traditional markets in Europe and Latin America.

Wheat imports to the LDC's are expected to increase by over 21 percent and the pattern of supplying areas is expected to shift. In the base period, 89 percent of these imports came from developed countries, 3 percent from the central plan countries, and 8 percent from LDC's, but in 1980 the share of imports from the developed areas is expected to decline to about 77 percent, from the central plan countries to increase to 12 percent, and from LDC's, increase to 11 percent. The about-stable volume of imports from the United States and increased imports from the Soviet Union and Argentina would be responsible for these shifts.

Rice

Set I projections indicate that 1980 world rice trade would be lower than in the base period by about 12 percent. A projected 28-percent decline in import needs in the LDC's—principally South and East Asia—is responsible for this trend. The LDC's would also be exporting less rice. In the base period, 20 percent of rice imports came from the developed regions (the United States and Australia), 13 percent from Communist Asia, and 67 percent from other LDC's (Southeast and East Asia and East South America). In 1980, the share of imports from the developed regions would increase to 33 percent, Communist Asia's share would remain the same, and the share from other LDC's would drop to 54 percent. The projected 1980 distribtuion is closer to that of the late 1960's, when rice exports from Southeast Asia faltered from the levels of the early 1960's and the United States emerged as the leading exporter of rice.

However, Southeast Asia as a group will undoubtedly retain its role as the biggest rice exporter at the world level, though its share in total world exports is expected to decrease from 53 percent in the base period to less than 40 percent in 1980. However, the direction of these exports would not change substantially. Southeast Asia's markets would appear to be East Asia, South Asia, Eastern Europe, the EC, and the United Kingdom, in that order.

In the base period, North Africa exported rice principally to the Soviet Union, Eastern Europe, and Western Europe. By 1980—under projection set I—its exports to the Soviet Union are expected to increase by more than 2.5 times, absorbing nearly half of the region's rice sales. The second half could go principally to West Africa, with a relatively small quantity going to Western Europe.

East South America, which in the base period shipped the bulk of its rice to other Latin American markets, the EC, West Africa, and Eastern Europe, could find it advantageous to export to the Republic of South Africa and to West Africa.

The U.S. share of world rice trade would increase over base period levels, but late-1960 gains would be maintained. According to the transportation model, the best markets for U.S. rice could be in Latin America, the EC, the United Kingdom, West Africa, West Asia, and Eastern Europe. The EC, however, was also projected to export rice, principally to Eastern Europe. Australia would more than treble her exports, and her best market could lie in East Africa rather than in Europe and the Far East as in the base period.

Under set I, 1980 rice exports from Communist China would remain about constant or drop slightly, but the direction of that trade may shift. Eastern Europe may disappear as a market; the volume of exports to Japan may treble, and in the less developed countries, her markets may shift from Latin America and the Far Eastern countries to East Africa and West and South Asia.

In evaluating some of the rice trade flows, the reader is cautioned that the model was not programmed to take into account different qualities of rice. If it had, some of the shifts might not have been projected. For example, Japan primarily consumes short-grain rice and Communist Asia exports medium-grain rice. Yet the model shows Japan importing all of its rice from its nearest source. Japan imports glutenous rice from Southeast Asia.

Coarse Grains

In contrast to wheat and rice trade, 1980 world trade in coarse grains under set I is expected to increase substantially—by about three-fourths. Both the developed and the less developed areas would share in this expansion. Only exports from the central plan countries are expected to diminish—by nearly one-half because of a rapid increase in their domestic demand. In the base period, the developed countries accounted for nearly 70 percent of world coarse grain exports; central plan countries, 10 percent; and the LDC's, 20 percent. By 1980, the developed countries would increase their share to 75 percent, the share of the central plan countries would decrease to 4 percent, and the share of the LDC's would remain about the same, though increasing in volume by 56 percent.

The United States would continue to be the largest exporter. Her main markets would remain in the developed world, with Japan and Western Europe

absorbing nearly 88 percent of these exports. Exports to Eastern Europe are expected to disappear as these countries may become modest exporters of coarse grains, but exports to Central America and South Asia will increase considerably.

Canada has been a minor exporter of coarse grains and her position could slip further from 4 percent of world exports in the base period to about 2 percent in 1980, with the United Kingdom and Other Western Europe continuing to absorb most of these exports. The EC, which in the base period exported about 2 million tons, would continue to be a major importer of coarse grains, principally from the United States and Argentina. The Republic of South Africa is expected to increase her exports considerably and her markets may shift substantially from Western Europe to West, South, and East Asia. She may also find it advantageous to seek markets in Communist Asia. Finally, exports from Australia would increase and the direction of these exports may also shift from Europe to Japan and Other East Asia countries.

In the less developed world, the principal coarse grain exporters with a considerable potential for growth are Argentina, East South America (Brazil), East Africa, and Southeast Asia. Argentina's exports in 1980 may nearly double over the base period. In the base period, over 90 percent of her exports went to Western Europe and Japan, but in 1980 about half could be directed to West Africa, East Asia, and South America; the volume of 1980 exports to Western Europe would remain about the same as in the base period.

The volume of coarse grain exports from East South America, principally Brazil, is not expected to change greatly from the base year level, but the direction of these exports may shift substantially. In the base period, over 90 percent of these grains went to Western Europe, Eastern Europe, and Japan. In 1980, markets in other Latin American countries could predominate. However, it is possible that some of the LDC markets would be available, but only under concessional terms: in that case, Argentina and Brazil would increase their share in the developed world, with the United States increasing its share in the LDC's. In Africa, in net trade terms, all three regions of the continent have been self-sufficient or imported a small amount of coarse grains. Under projection set I, however, East Africa would become an exporter, shipping 1.2 million tons in 1980, with the most likely market in West Asia. Finally, Southeast Asia is expected to increase its coarse grain exports by over 60 percent, with Japan continuing to be its principal market.

Although coarse grain exports from the less developed area are projected to increase in 1980 by 56 percent over the base period level, import needs are expected to grow much faster. Imports from all regions would increase considerably, with some changes in the relative importance of supplying regions. The share from the developed countries is projected to increase from 70 percent to 75 percent, while the share from exporting LDC's will increase from 10 percent to 20 percent. Central America and South Asia are expected to continue to rely on supplies from the developed countries, principally the United States and South Africa. North Africa could become a principal market for Eastern Europe's coarse grains. East Asia, West Asia, West Africa, and West South America are projected to depend heavily on supplies from exporting LDC's. Because of foreign exchange problems, some of these projected imports may only materialize if concessional terms are available. Under these circumstances, more of the import demand in the LDC's would be filled by the developed exporters, with the LDC exporters probably increasing their share in the developed market.

Projection Set II

Accelerated agricultural production in the less developed countries coupled with price stabilization policies in major developed exporting countries necessarily implies a retrenchment on the part of developed exporters and a higher level of LDC exports because increased output in LDC's overtakes the growth in demand. Hence, this projection set means a realignment of world trade from the patterns of the 1963-65 base period and projection set I.

Wheat

Total wheat exports from developed exporters would drop considerably from about 45 million tons in set I to about 37 million tons in set II, primarily because increased wheat production shifts South Asia from an importer to a substantial exporter, but also because of increased exports by Argentina.

Exports from the United States would drop by a fourth from levels in set I and except for concessional sales, the country would lose its Asian markets. U.S. exports to other areas would continue but at lower levels. Canadian wheat exports would also drop by a fourth as Canada would be replaced by Australia and South Asia in the Communist Asia market. For Australia, the increased exports to Communist Asia compensate partially for the loss of other Asian markets. With lower world wheat prices, feed use of wheat is expected to increase in the EC, thus lowering its exports.

The increase in wheat exports from Argentina, a traditional wheat exporter, would be accounted for by larger shipments to other Latin American countries. South Asia would become a substantial wheat exporter,

shipping over 7 million tons on a net trade basis. The bulk of these exports would be shipped to nonwheat-producing countries of East Asia. Lack of foreign exchange in East Asian countries might limit the market potential in this area, unless exports were financed through some international consortium. Communist Asia and Southeast Asia might also become important markets. Thus, South Asia—mainly India and Pakistan—would be the chief beneficiaries of the improved wheat supply position of the LDC's under set II, though West Asia might also benefit to some extent because of lower wheat import needs.

Rice

Because most of the world import demand for rice is centered in the LDC's, the projected accelerated growth in rice production in those regions—mainly South and East Asia—would considerably lower the level of world rice trade, thereby causing downward pressure on prices. The developed exporters (primarily the United States) would reduce their exports to try to maintain prices at reasonable levels (as assumed under set II). But their withdrawals from the market would not be enough to maintain prices. The expected low prices of rice under set II would increase rice imports in the developed world but not enough to compensate for the reduced levels in the less developed importing countries.

Interestingly, according to the transportation model, the United States would lose its traditional markets and would ship to Eastern Europe. This results because Danzig, Poland, was chosen as the import point for Eastern Europe and the shipping rates from the United States are more favorable than from other rice exporters.

Total rice exports of the LDC's would increase in projection set II by some 55 percent over the level of set I. West South America would become a net exporter of 100,000 tons, shipping principally to Central America. East South American exports would increase by nearly three-fourths, with most going to other Latin American countries. North Africa's exports would increase by a fourth, mostly through the expansion of exports to the Soviet Union and Other Western Europe. Finally, the principal exporter, Southeast Asia, would increase its exports by 13 percent to 2.8 million tons. Its position in the Asian markets would improve and it might possibly develop new markets in East and West Africa.

Thus, in general, the accelerated Green Revolution in rice production would benefit more less developed countries, particularly in Asia, than would the corresponding event in wheat production, which would be concentrated in one, albeit large, region.

Coarse Grains

The total level of world trade in coarse grains would drop from 50.4 million tons in projection set I to 46.7 million tons in set II. Exports from the less developed countries would increase by nearly 7 million tons, while exports from the developed regions would drop by more than 10 million tons. Nearly 9 million tons of this decline would be accounted for by the United States as she withdrew from the market to help maintain "world prices".

In particular, the United States would lose a large proportion of its Japanese, EC, and Central American markets. Canada's exports to the United Kingdom would contract considerably and South Africa would lose its Asian markets, but improve its exports to Japan.

In the central plan area, Eastern Europe and the Soviet Union would imporve their exports to Western Europe, but their exports to North Africa would be reduced considerably.

Among the LDC's, the principal shippers would remain Argentina, East South America, East Africa, and Southeast Asia, and their exports would expand considerably. Argentina's exports to Other Western Europe would increase by nearly four times, but exports to West South America and Asia would disappear and those to West Africa would contract. East South America would expand its exports to Western Europe, West South America, and West Africa. East Africa could expand its exports to West Asia. Lastly, Southeast Asia's expanded production potential would find its principal export outlets in Japan and East Asia, but some exports could also move to South Asia.

Thus, accelerated coarse grain production in the LDC's would double their exports to developed countries, principally Japan and Other Western Europe, and increase by a third their trade with other LDC's. The benefits from this trade would be fairly widely spread among the potential coarse grain exporters.

Table C-1.--World trade in wheat and wheat flour, 1963-65 average

Exporting Regions	Developed								Central Plan				Less developed										World total exports
	United States	Canada	Japan	EC	United King-dom	Other West Europe	Aust. N.Z. S. Afr.	Sub-total	East Europe	USSR	Commu-nist Asia	Sub-total	Argen-tina	Other Latin Am.	North Africa	West Africa	East Africa	West Asia	South Asia	South-east Asia	Other East Asia	F. East & Oceania	Sub-total	
	1,000 metric tons																						
Developed:																							
United States	--	--	1,753	1,111	311	570	47	3,792	1,608	595	--	2,203	--	2,547	2,155	199	38	1,241	6,896	143	1,185	114	14,518	20,513
Canada	77	--	1,322	1,361	2,282	514	108	5,664	1,193	3,437	1,537	6,167	--	796	4	77	7	46	168	16	217	59	1,390	13,221
Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	30	41	76	76
EC	--	--	9	613	687	401	--	1,710	1,118	521	451	2,090	--	140	679	194	71	121	93	6	13	38	1,355	5,155
United Kingdom	--	--	--	--	--	67	--	67	--	--	--	--	--	--	26	--	4	16	1	--	--	--	47	585
Other West Europe	--	--	--	137	68	--	--	205	266	--	--	266	--	--	--	--	--	--	--	--	--	--	--	--
Australia, N. Zeal., Un. S. Afr.	--	--	429	52	620	191	175	1,467	17	902	2,503	3,422	--	3	14	--	100	373	451	32	99	270	1,342	6,231
Subtotal	77	--	3,513	3,274	3,968	1,743	330	12,905	4,202	5,455	4,202	14,148	--	3,486	2,878	470	220	1,797	7,609	202	1,544	522	18,728	45,781
Central Plan:																							
Eastern Europe	--	--	--	2	1	4	--	7	39	9	--	48	--	--	--	--	--	--	15	--	--	--	15	70
USSR	--	--	14	88	100	153	--	355	1,823	--	--	1,823	--	452	63	--	--	2	3	--	44	--	564	2,742
Communist Asia	--	--	--	--	--	--	--	--	--	52	--	52	--	--	--	--	--	--	1	--	1	--	2	54
Subtotal	--	--	14	90	101	157	--	362	1,862	61	--	1,923	--	452	63	--	--	2	19	--	45	--	581	2,866
Less Developed:																							
Argentina	--	--	1	772	298	144	--	1,215	176	290	837	1,303	--	1,396	20	--	12	17	--	--	4	--	1,449	3,967
Other Latin America	--	--	--	7	--	--	--	7	17	--	--	17	--	40	--	3	--	5	--	--	--	--	48	72
North Africa	--	--	--	57	1	5	--	63	4	--	--	4	--	--	10	--	--	--	--	--	--	--	10	77
West Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	2	--	--	--	--	5	5
East Africa	--	--	--	4	--	--	--	4	--	--	--	--	--	--	--	--	4	--	--	--	--	--	4	8
West Asia	--	--	--	24	--	--	--	24	--	--	--	--	--	--	4	--	--	45	--	1	--	--	50	74
South Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	3	3
South E. Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1	1
Other E. Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	9	19	23	54	54
Far East & Oceania	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	20	21	21
Subtotal	--	--	1	864	299	149	--	1,313	197	290	837	1,324	--	1,436	34	4	19	72	4	10	23	43	1,645	4,282
WORLD TOTAL IMPORTS	77	--	3,528	4,228	4,368	2,049	330	14,580	6,261	5,806	5,328	17,395	--	5,374	2,975	474	239	1,871	7,632	212	1,617	565	20,954	52,929

. Source: Computed from tables 66-68 in (89).

Table C-2.--World trade in wheat, 1980, projection set I 1/

Exporting Regions	Importing Regions: Developed									Central Plan				Less Developed										World total exports
	United States	Canada	Japan	EC	United Kingdom	OWE	South Africa Rep.	Aust. & N.Z.	Sub-total	East Europe	USSR	Commu-nist Asia	Sub-total	Cent. Amer.	East S. Amer.	West S. Amer.	Argen-tina	North Africa	West Africa	East Africa	West Asia	South Asia	South-east Asia	East Asia & Pac. Is.	Sub-total	
	1,000 metric tons																								
Developed:																									
United States	--	--	3,923	1,000	449	--	--	--	5,372	--	--	--	--	2,283	2,086	--	--	3,370	--	--	4,092	2,114	--	--	13,945	19,317
Canada	--	--	1,961	1,000	3,141	--	--	--	6,102	--	--	3,254	3,254	--	--	2,427	--	--	--	--	--	114	--	--	2,541	11,897
Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EC	--	--	--	--	--	--	--	--	--	1,095	--	--	1,095	--	--	--	--	2,135	1,483	712	--	151	304	--	4,785	5,880
United Kingdom	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other W. Europe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	508	--	--	--	--	--	--	508	508
S. Africa Rep.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Austr. & N.Z.	--	--	654	--	--	--	--	--	654	--	--	2,858	2,858	--	--	--	--	--	--	--	--	--	127	4,179	4,306	7,818
Subtotal	--	--	6,538	2,000	3,590	--	--	--	12,128	1,095	--	6,112	7,207	2,283	2,086	2,427	--	6,013	1,483	712	4,092	2,379	431	4,179	26,085	45,420
Central Plan:																										
Eastern Europe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USSR	--	--	--	--	--	--	--	--	--	730	--	--	730	--	--	--	--	2,934	--	--	916	--	--	--	3,850	4,580
Communist Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtotal	--	--	--	--	--	--	--	--	--	730	--	--	730	--	--	--	--	2,934	--	--	916	--	--	--	3,850	4,580
Less Developed:																										
Central America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E. South America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W. South America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Argentina	--	--	--	--	897	--	473	--	1,370	--	--	--	--	--	2,840	985	--	--	--	--	--	--	--	--	3,825	5,195
North Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Southeast Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Asia & Pac. Is.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtotal	--	--	--	--	897	--	473	--	1,370	--	--	--	--	--	2,840	985	--	--	--	--	--	--	--	--	3,825	5,195
World total imports	--	--	6,538	2,000	4,487	--	473	--	13,498	1,825	--	6,112	7,937	2,283	4,926	3,412	--	8,947	1,483	712	5,008	2,379	431	4,179	33,760	55,195

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the LDC's.

Table C-3.--World trade in wheat, 1970, projection set II 1/

Exporting Regions	Importing Regions: Developed: United States	Canada	Japan	EC	United Kingdom	Other West Europe	South Africa Rep.	Aust. & N.Z.	Sub-total	Central Plan: East Europe	USSR	Commu-nist Asia	Sub-total	Less Developed: Cent. Am.	East South Am.	West South Am.	Argen-tina	North Africa	West Africa	East Africa	West Asia	South Asia	South East Asia	EAsia & Pac. Is.	Sub-total	World trade exports
	1,000 metric tons																									
Developed:																										
United States	--	--	2,952	1,000	457	--	--	--	4,409	--	--	--	--	2,101	1,152	--	--	5,115	--	--	--	2,000	--	--	10,368	14,777
Canada	--	--	1,940	1,000	3,201	--	--	--	6,141	--	--	--	--	--	73	2,533	--	--	--	--	--	--	--	--	2,606	8,747
Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EC	--	--	--	--	--	--	--	--	--	1,105	--	--	1,105	--	--	--	--	995	1,624	704	--	--	--	--	3,323	4,428
United Kingdom	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other West Europe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	572	--	--	--	--	--	--	572	572
South Africa, Rep.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Australia & New Zealand	--	--	1,575	--	--	--	--	--	1,575	--	--	5,220	5,220	--	--	--	--	--	--	--	--	--	--	--	--	6,795
Subtotal	--	--	6,467	2,000	3,658	--	--	--	12,125	1,105	--	5,220	6,325	2,101	1,225	2,533	--	6,682	1,624	704	--	2,000	--	--	16,869	35,319
Central Plan:																										
Eastern Europe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USSR	--	--	--	--	--	--	--	--	--	737	--	--	737	--	--	--	--	2,930	--	--	917	--	--	--	3,847	4,584
Communist Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtotal	--	--	--	--	--	--	--	--	--	737	--	--	737	--	--	--	--	2,930	--	--	917	--	--	--	3,847	4,584
Less Developed:																										
Central America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East South America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West South America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Argentina	--	--	--	--	915	--	460	--	1,375	--	--	--	--	--	3,779	1,001	--	--	--	--	--	--	--	--	4,780	6,155
North Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South Asia	--	--	--	--	--	--	--	--	--	--	--	907	907	--	--	--	--	--	--	--	--	3,402	--	417	4,413	8,232	9,139
South East Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Asia & Pacific Is.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtotal	--	--	--	--	915	--	460	--	1,375	--	--	907	907	--	3,779	1,001	--	--	--	--	--	3,402	--	417	4,413	13,012	15,294
WORLD TOTAL IMPORTS	--	--	6,467	2,000	4,573	--	460	--	13,500	1,842	--	6,127	7,969	2,101	5,004	3,534	--	9,612	1,624	704	4,319	2,000	417	4,413	33,728	55,197

1/ Set II assumes that agricultural productivity and economic growth in the LDC's would be higher than projected in set I. Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the LDC's.

Table C-4.--World trade in rice, 1963-65 average

Exporting Regions	Importing regions: Developed: United States	Canada	Japan	EC	United Kingdom	Other West Europe	Aust. & N.Z.	Subtotal	Central plan: East Europe	USSR	Commun. Asia	Subtotal	Less developed: Argentina	Other Latin Am.	North Africa	West Africa	East Africa	West Asia	South Asia	Southeast Asia	Other East Asia	F. East & Oceania	Subtotal	World total exports
	1,000 metric tons																							
Developed:																								
United States	0	29	132	85	44	30	61	381	12	18	0	30	--	121	1	163	4	89	277	62	120	92	929	1,340
Canada	5	15	--	--	--	--	--	20	--	--	--	0	--	--	--	--	--	--	--	--	--	--	0	20
Japan	--	--	--	--	--	--	--	0	--	--	--	0	--	--	--	--	--	--	--	--	7	--	7	7
EC	5	1	--	42	8	57	--	113	25	7	--	32	--	2	6	3	--	8	--	--	--	--	19	164
United Kingdom	0	0	0	0	0	0	0	0	32	0	0	32	--	--	--	2	--	0	--	--	--	--	12	73
Other West Europe	0	0	21	4	2	2	--	29	--	0	0	0	--	--	--	--	--	7	--	--	--	--	--	--
Australia & New Zealand	--	2	--	--	6	0	2	10	--	--	--	0	--	0	--	--	--	--	--	--	3	29	32	42
Subtotal	10	47	153	131	60	89	63	553	69	25	--	94	--	126	7	168	4	104	277	62	130	121	999	1,646
Central plan:																								
Eastern Europe	--	--	--	--	--	--	--	0	--	--	--	--	--	0	--	--	--	--	--	--	--	--	0	0
USSR	--	--	--	--	--	--	--	0	--	--	3	3	--	3	--	--	--	--	--	--	--	--	3	6
Communist Asia	--	--	56	6	6	--	--	68	28	15	21	64	--	149	5	3	6	7	210	--	140	181	701	833
Subtotal	0	0	56	6	6	--	--	68	28	15	24	67	--	152	5	3	6	7	210	--	140	181	704	839
Less developed:																								
Argentina	--	--	--	4	3	3	--	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other Latin America	--	7	--	24	4	6	--	41	17	--	--	17	--	91	3	22	7	1	--	--	--	--	124	182
North Africa	--	--	--	30	7	17	--	54	70	96	--	166	0	0	5	6	0	0	5	--	--	--	16	236
West Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1	1
East Africa	--	--	--	14	0	2	--	16	--	--	--	0	--	--	--	--	16	--	--	--	--	--	16	32
West Asia	--	--	--	--	--	--	--	0	--	1	--	1	--	--	--	--	--	2	--	--	--	--	2	3
South Asia	--	--	--	2	3	0	--	5	7	--	--	7	--	--	--	6	9	74	44	--	3	10	146	158
South East Asia	--	1	167	97	30	12	6	313	127	112	62	301	--	58	1	164	163	105	771	61	621	1,221	3,165	3,779
Other East Asia	3	--	165	--	--	--	--	168	--	--	--	0	--	--	--	--	--	--	1	--	18	17	36	204
Far East & Oceania	--	--	--	--	--	--	--	0	--	--	--	0	--	--	--	--	5	5	6	--	9	41	66	66
Subtotal	3	8	332	171	47	40	6	607	221	209	62	492	--	149	9	199	200	187	827	61	651	1,289	3,572	4,671
World total imports	13	55	541	308	113	129	69	1,228	318	249	86	653	--	427	21	370	210	298	1,314	123	921	1,591	5,275	7,156

Source: Computed from tables 96-98 in (89).

Table C-5.--World trade in rice, 1980, projection set I 1/

Exporting Regions	Importing Regions: Developed: United States	Canada	Japan	EC	United Kingdom	Other West Europe	South Africa Rep.	Aust. & N.Z.	Sub-total	Central Plan: East Europe	USSR	Commu-nist Asia	Sub-total	Less developed: Cent. Am.	West South Am.	East South Am.	Argen-tina	North Africa	West Africa	East Africa	West Asia	South Asia	EAsia & Pac Is.	South East Asia	Sub-total	World total exports
	1,000 metric tons																									
Developed:																										
United States	--	64	--	333	114	--	--	--	511	142	--	--	142	503	22	--	--	--	559	--	326	--	--	--	1,410	2,063
Canada	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EC	--	--	--	--	--	--	--	--	--	106	--	--	106	--	--	--	--	--	--	--	--	--	--	--	--	106
United Kingdom	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other Western Europe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South Africa Rep.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Australia & New Zealand	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	157	--	--	--	--	157	157
Subtotal	--	64	--	333	114	--	--	--	511	248	--	--	248	503	22	--	--	--	559	157	326	--	--	--	1,567	2,326
Central Plan:																										
Eastern Europe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USSR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Communist Asia	--	--	170	--	--	--	--	--	170	--	--	--	--	--	--	--	--	--	--	229	249	120	--	--	598	768
Subtotal	--	--	170	--	--	--	--	--	170	--	--	--	--	--	--	--	--	--	--	229	249	120	--	--	598	768
Less Developed:																										
Central America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West South America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East South America	--	--	--	--	--	--	90	--	90	--	--	--	--	--	--	--	--	--	--	68	--	--	--	--	68	158
Argentina	--	--	--	--	--	--	42	--	42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	42
North Africa	--	--	--	--	--	40	--	--	40	--	266	--	266	--	--	--	--	--	232	--	--	--	--	--	232	538
West Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Asia & Pacific Is.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South East Asia	--	--	--	75	20	--	--	--	95	107	--	--	107	--	--	--	--	--	--	--	--	650	1,627	--	2,277	2,479
Subtotal	--	--	--	75	20	40	132	--	267	107	266	--	373	--	--	--	--	--	232	68	--	620	1,627	--	2,577	3,217
WORLD TOTAL IMPORTS	--	64	170	408	134	40	132	--	948	355	266	--	621	503	22	--	--	--	791	454	575	770	1,627	--	4,742	6,311

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the LDC's.

Table C-6.--World trade in rice, 1980, projection set II 1/

Exporting Regions	Importing Regions: Developed: United States	Canada	Japan	EC	United Kingdom	Other West Europe	South Africa Rep.	Aust. & N.Z.	Sub-total	Central plan: East Europe	USSR	Commu-nist Asia	Sub-total	Less Developed: Cent. Am.	West South Am.	East South Am.	Argen-tina	North Africa	West Africa	East Africa	West Asia	South Asia	EAsia & Pac Is.	South East Asia	Sub-total	World total exports
	1,000 metric tons																									
Developed:																										
United States	--	--	--	--	--	--	--	--	--	147	--	--	147	--	--	--	--	--	--	--	--	--	--	--	--	147
Canada	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EC	--	35	--	--	--	--	--	--	35	110	--	--	110	--	--	--	--	--	--	--	--	--	--	--	--	145
United Kingdom	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other Western Europe	--	--	--	292	--	--	--	--	292	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	292
South Africa Rep.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Australia & New Zealand	--	--	--	104	--	--	--	--	104	--	--	--	--	--	--	--	--	--	36	--	--	--	--	--	36	140
Subtotal	--	35	--	396	--	--	--	--	431	257	--	--	257	--	--	--	--	--	36	--	--	--	--	--	36	724
Central Plan:																										
Eastern Europe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USSR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Communist Asia	--	--	365	--	119	--	--	--	484	--	--	--	--	--	--	--	--	--	--	--	90	--	--	--	90	574
Subtotal	--	--	365	--	119	--	--	--	484	--	--	--	--	--	--	--	--	--	--	--	90	--	--	--	90	574
Less Developed:																										
Central America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West South America	--	--	--	--	--	--	--	--	--	--	--	--	--	393	--	--	--	--	--	--	--	--	--	--	393	393
East South America	--	30	--	--	--	--	56	--	86	--	--	--	--	--	293	--	--	--	--	--	--	--	--	--	293	379
Argentina	--	--	--	--	--	--	81	--	81	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	81
North Africa	--	--	--	--	--	374	--	--	374	--	288	--	288	--	--	--	--	--	--	--	--	--	--	--	--	662
West Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Asia & Pacific Is.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South East Asia	--	--	--	84	21	--	--	--	105	110	--	--	110	--	--	--	--	--	602	437	374	117	1,046	--	2,576	2,791
Subtotal	--	30	--	84	21	374	137	--	646	110	288	--	398	393	293	--	--	--	602	437	374	117	1,046	--	3,262	4,306
WORLD TOTAL IMPORTS	--	65	365	480	140	374	137	--	1,561	367	288	--	655	393	293	--	--	--	638	437	464	117	1,046	--	3,388	5,604

1/ Set II assumes that agricultural productivity and economic growth in the LDC's would be higher than projected in set I. Set I assumes a continuation of present food and fiber policies, allowing or moderate gains in productivity in the LDC's

Table C-7.--World trade in coarse grains, 1963-65 average

Exporting Regions	Importing Regions: Developed: United States	Canada	Japan	EC	United Kingdom	Other West Europe	Aust., N.Z., S. Afr.	Sub-total	Central Plan: East Europe	USSR	Commu-nist Asia	Sub-total	Less developed: Argentina	Other Latin Am.	North Africa	West Africa	East Africa	West Asia	South Asia	South-east Asia	Other East Asia	F. East & Oceania	Sub-total	World total exports
	1,000 metric tons																							
Developed:																								
United States	--	374	2,800	6,904	2,091	2,181	--	14,350	303	--	--	303	2	388	278	79	33	384	139	16	183	--	1,502	16,155
Canada	151	--	125	298	485	98	--	1,157	28	--	171	199	--	20	--	1	1	--	--	--	12	--	34	1,390
Japan	--	--	--	--	--	--	--	0	--	--	--	0	--	--	--	--	--	--	--	--	--	--	0	0
EC	12	--	4	1,783	476	1,188	--	3,463	285	--	51	336	--	7	7	10	--	7	--	--	--	--	31	3,830
United Kingdom	--	--	--	111	0	35	--	146	41	--	--	41	--	0	0	--	--	0	--	--	--	--	0	187
Other West Europe	1	--	--	271	30	135	--	437	67	--	--	67	--	10	1	--	--	25	--	--	--	--	36	540
Australia, N. Zeal., Un. S. Afr.	9	--	582	645	645	65	2	1,948	7	--	14	21	--	36	--	3	68	14	1	--	10	2	134	2,103
Subtotal	173	374	3,511	10,012	3,727	3,702	2	21,501	731	--	236	967	2	461	286	93	102	430	140	16	205	2	1,737	24,205
Central Plan:																								
Eastern Europe	--	--	55	513	153	291	--	1,012	362	--	--	362	--	4	--	--	--	27	--	--	--	--	31	1,406
USSR	--	--	42	150	--	140	--	332	1,522	--	--	1,522	--	190	--	--	--	--	--	--	--	--	190	2,044
Communist Asia	--	--	144	--	--	--	--	144	--	--	--	0	--	6	--	--	--	--	--	--	--	--	6	150
Subtotal	--	--	241	663	153	431	--	1,488	1,884	--	--	1,884	--	200	--	--	--	27	--	--	--	--	227	3,599
Less Developed:																								
Argentina	13	--	148	2,963	162	325	--	3,611	38	--	126	164	--	130	--	--	--	13	--	--	3	--	146	3,921
Other Latin America	3	--	110	385	53	21	--	572	305	--	--	305	--	59	--	8	1	3	--	--	9	--	80	957
North Africa	--	--	--	99	10	162	--	271	15	--	--	15	0	0	15	1	--	14	--	--	--	--	30	316
West Africa	--	--	--	--	5	87	--	92	--	--	--	0	0	0	--	5	--	--	--	--	--	--	5	97
East Africa	--	--	42	30	34	0	--	106	--	--	--	0	--	--	--	3	33	--	--	--	--	--	36	142
West Asia	--	--	1	132	5	80	--	218	58	--	--	58	0	0	7	--	--	163	--	--	--	--	170	446
South Asia	--	--	--	2	--	--	--	2	77	--	--	77	--	--	--	--	--	--	--	--	--	--	0	79
South East Asia	--	--	599	17	--	--	--	616	5	--	3	8	--	--	--	--	23	10	3	--	138	166	340	964
Other East Asia	--	--	5	--	--	--	--	5	--	--	--	0	--	--	--	--	--	--	--	--	5	--	5	10
Far East & Oceania	--	--	1	--	--	--	--	1	--	--	--	0	--	--	--	--	--	--	--	--	--	1	1	2
Subtotal	16	0	906	3,628	269	675	0	5,494	498	--	129	627	0	627	22	17	57	203	3	--	155	167	813	6,934
WORLD TOTAL IMPORTS	189	374	4,658	14,303	4,149	4,808	2	28,483	3,113	--	365	3,478	--	850	308	110	159	660	143	16	360	169	2,777	34,738

Source: Computed from tables 51-53 in (89).

Table C-8.--World trade in coarse grains, 1980, projection set I 1/

Exporting Regions	Importing Regions: Developed: United States	Canada	Japan	EC	United Kingdom	OWE	South Africa Rep.	Aust. & N.Z.	Sub-total	Central Plan: East Europe	USSR	Commu-nist Asia	Sub-total	Less Developed: Cent. Amer.	East S. Amer.	West S. Amer.	Argentina	North Africa	West Africa	East Africa	West Asia	South Asia	South-east Asia	East Asia & Pac. Is.	Sub-total	World total exports
	1,000 metric tons																									
Developed:																										
United States	--	--	1,820	8,445	861	2,246	--	--	26,372	--	--	--	--	2,208	--	--	--	--	--	--	--	1,400	--	--	3,608	29,980
Canada	--	--	--	--	861	202	--	--	1,063	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,063
Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
United Kingdom	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other W. Europe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S. Africa Rep.	--	--	--	--	--	--	--	--	--	--	--	298	298	--	--	--	--	--	--	--	1,581	1,400	--	631	3,612	3,910
Austr. & N.Z.	--	--	1,131	--	--	--	--	--	1,131	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,697	1,697	2,828
Subtotal	--	--	15,951	8,445	1,722	2,448	--	--	28,566	--	--	--	--	--	--	--	--	--	--	--	1,581	2,800	--	2,328	8,917	37,781
Central Plan:																										
Eastern Europe	--	--	--	--	--	134	--	--	134	--	--	--	--	--	--	--	--	973	--	--	--	--	--	--	973	1,107
USSR	--	--	--	--	--	736	--	--	736	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	736
Communist Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtotal	--	--	--	--	--	870	--	--	870	--	--	--	--	--	--	--	--	973	--	--	--	--	--	--	973	1,843
Less Developed:																										
Central America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E. South America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,044	--	--	--	--	--	--	--	--	1,044	1,044
W. South America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Argentina	--	--	--	1,596	--	1,770	--	--	3,366	--	--	--	--	--	--	179	--	--	2,842	--	--	--	--	610	3,631	6,997
North Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,208	--	--	--	1,208	1,208
West Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Southeast Asia	--	--	785	--	--	--	--	--	785	--	--	--	--	--	--	--	--	--	--	--	--	--	--	785	785	1,570
East Asia & Pac. Is.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtotal	--	--	785	1,596	--	1,770	--	--	4,151	--	--	--	--	--	--	1,223	--	--	2,842	--	1,208	--	--	1,395	6,668	10,819
World total imports	--	--	16,736	10,041	1,722	5,088	--	--	33,587	--	--	298	298	2,208	--	1,223	--	973	2,842	--	2,789	2,800	--	3,723	16,558	50,443

1/ Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the LDC's.

Table C-9.--World trade in coarse grains, 1980, projection set II 1/

Exporting Regions	Importing Regions: Developed: United States	Canada	Japan	EC	United Kingdom	Other West Europe	South Africa Rep.	Aust. & N.Z.	Sub-total	Central plan: East Europe	USSR	Commu-nist Asia	Sub-total	Cent. Am.	Less Developed: East South Am.	West South Am.	Argen-tina	North Africa	West Africa	East Africa	West Asia	South Asia	South East Asia	EAsia & Pac. Is.	Sub-total	World total exports
	1,000 metric tons																									
Developed:																										
United States	--	--	10,427	6,683	2,057	--	--	--	19,167	--	--	--	--	653	--	--	--	--	--	--	--	1,210	--	--	1,863	21,030
Canada	--	--	--	--	365	--	--	--	365	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	365
Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
United Kingdom	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other West Europe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South Africa, Rep.	--	--	2,684	--	--	--	--	--	2,684	--	--	376	376	--	--	--	--	--	--	--	--	382	--	--	382	3,442
Australia & New Zealand	--	--	2,675	--	--	--	--	--	2,675	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,675
Subtotal	--	--	15,786	6,683	2,422	--	--	--	24,891	--	--	376	376	653	--	--	--	--	--	--	--	1,592	--	--	2,245	27,512
Central Plan:																										
Eastern Europe	--	--	--	523	492	--	--	--	1,015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,015
USSR	--	--	--	--	--	196	--	--	196	--	--	--	--	--	--	--	--	378	--	--	--	--	--	--	378	574
Communist Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtotal	--	--	--	523	492	196	--	--	1,211	--	--	--	--	--	--	--	--	378	--	--	--	--	--	--	378	1,589
Less Developed:																										
Central America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East South America	--	--	--	596	--	--	--	--	596	--	--	--	--	--	--	1,168	--	--	1,267	--	--	--	--	--	2,435	3,031
West South America	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Argentina	--	--	--	1,483	--	5,969	--	--	7,452	--	--	--	--	--	--	--	--	--	970	--	--	--	--	--	970	8,422
North Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
West Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
East Africa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,559	717	--	--	3,276	3,276
West Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South Asia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
South East Asia	--	--	1,444	--	--	--	--	--	1,444	--	--	--	--	--	--	--	--	--	--	--	--	111	--	1,332	1,443	2,887
East Asia & Pacific Is.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtotal	--	--	1,444	2,079	--	5,969	--	--	9,492	--	--	--	--	--	--	1,168	--	--	2,237	--	2,559	828	--	1,332	8,124	17,616
WORLD TOTAL IMPORTS	--	--	17,230	9,285	2,914	6,165	--	--	35,594	--	--	376	376	653	--	1,168	--	378	2,237	--	2,559	2,420	--	1,332	10,747	46,717

1/ Set II assumes that agricultural productivity and economic growth in the LDC's would be higher than projected in set I. Set I assumes a continuation of present food and fiber policies, allowing for moderate gains in productivity in the LDC's.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1971 O-483-193 (ERS-56)

Results of the project of which this report is a part have been published as follows by the Economic Research Service:

World Trade in Selected Agricultural Commodities, 1951-65

Vol. I.—Beverage Crops: Coffee, Cocoa, and Tea. Foreign Agr. Econ. Rpt. 42, June 1968

Vol. II.—Food and Feed Grains: Wheat, Rice, Maize, Barley, and Other Cereals. Foreign Agr. Econ. Rpt. 45, June 1968

Vol. III.—Textile Fibers: Cotton, Jute, and Other Vegetable Fibers. Foreign Agr. Econ. Rpt. 43, June 1968

Vol IV.—Sugar, Fruits, and Vegetables. Foreign Agr. Econ. Rpt. 44, June 1968

Vol V.—Oilseeds, Oil Nuts, and Animal and Vegetable Oils. Foreign Agr. Econ. Rpt. 47, Aug. 1968

Japan's Food Demand and 1985 Grain Import Prospects. Foreign Agr. Econ. Rpt. 53, June 1969

World Demand Prospects for Agricultural Exports of Less Developed Countries. Foreign Agr. Econ. Rpt. 60, June 1970

World Demand Prospects for Wheat in 1980 with Emphasis on Trade by Less Developed Countries. Foreign Agr. Econ. Rpt. 62, July 1970

Growth in World Demand for Feed Grains: Related to Meat and Livestock Products and Human Consumption of Grains, 1980. Foreign Agr. Econ. Rpt. 63, July 1970

World Demand Prospects for Cotton in 1980 with Emphasis on Trade by Less Developed Countries. Foreign Agr. Econ. Rpt. 000, Jan. 1971

World Demand Prospects for Bananas in 1980 with Emphasis on Trade by Less Developed Countries. Foreign Agr. Econ. Rpt. 69, Feb. 1971

World Demand and Supply Prospects for Oilseeds and Oilseed Products in 1980 with Emphasis on Trade by the Less Developed Countries. Foreign Agr. Econ. Rpt. 71, Mar. 1971

Copies of these reports may be obtained upon request to the Division of Information, Office of Management Services, U.S. Department of Agriculture, Washington, D.C. 20250.

Additional reports are being developed on the following as part of the overall research project: World agricultural import barriers and world demand prospects in 1980 for rice and coffee. Publication of these reports will be announced.